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ABSTRACT

This instructional resource guide is intended to assist the industrial arts (IA) teacher in implementing a comprehensive materials and Processes Technology program at the technical level in Virginia high schools. The course is designed to help students make informed educational and occupational choices and prepare them for advanced technical or vocational programs in a related cluster of occupations. Section 1 discusses Virginia IA curriculum, including mission, goals, instructional objectives, and student organization. Section 2 provides a course description, course goals, suggested outline for content/concepts and topics, and key to guide usage. Thirteen units of study comprise section 3: (1) Materials and Processes Technology, (2) Safety Procedures, (3) Industrial Technology Careers, (4) In-class IA Student Association, (5) Nature of Materials, (6) Classifications of Materials, (7) Properties of Materials, (8) Materials Processing, (9) Plastics, (10) Metals, (11) Woods, (12) Ceramics, and (13) Composites. Each unit supplies this information: tasks, topics, teacher's guide, note, student's performance guide, resources/media, equipment, and supplies. Section 4 lists the resources and supporting media used in the course. Section 5 contains over twenty experiments, activities, and projects. Sources of free or inexpensive information and materials are listed in section 6. The final section provides a Materials and Processes Technology Laboratory Design Concept and IA Education Service Approved Equipment List. (YLB)

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PREFACE

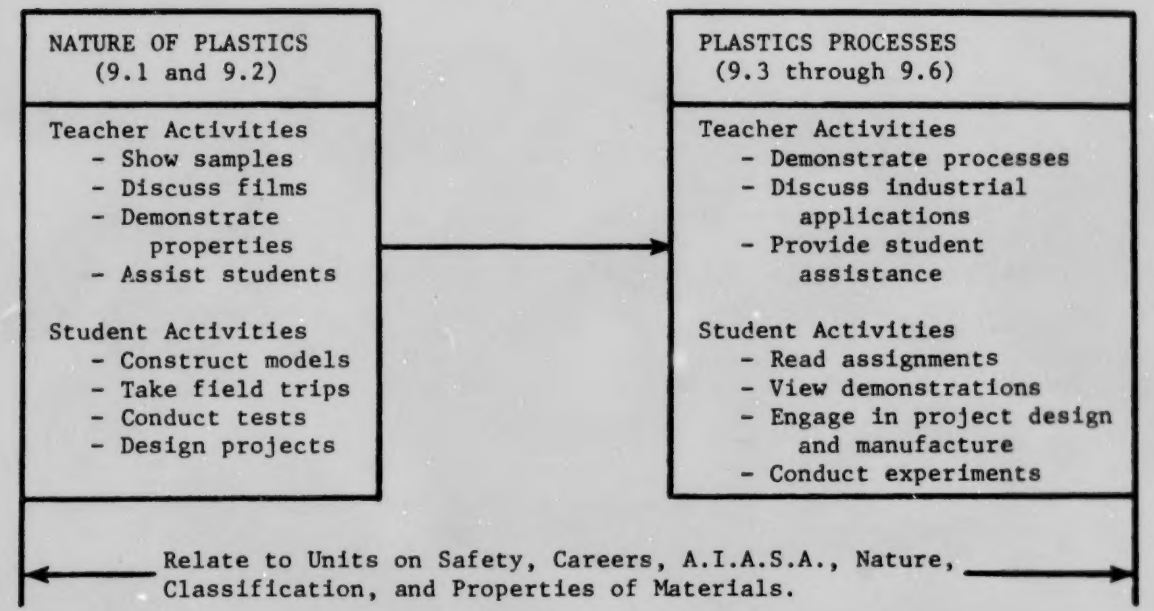
Industrial Arts is a subject area which assists learners to develop an understanding of technology and industry and aids them to discover and develop individual potentials related to these areas. The following instructional resource guide focuses on only one course of study recommended for all learners in the Virginia industrial arts curriculum. Its purpose is to provide experiences with industrial/technical materials and processes which are commonly found in industrial and consumer products. In this manner it assists in identifying career potentials for students interested in technical careers (engineers, designers, technicians, and craftsmen) and other students interested in improving their consumer knowledge and technological literacy. Suggested activities for both instructors and students are provided in woods, metals, plastics, ceramics, and composite materials in the knowledge, skill, and attitudinal domains.

This guide has been assembled to assist teachers to develop instructional programs at the local level. Information contained within the following pages is only a guide. Teachers should utilize it as a resource in developing programs to meet the needs of their individual students. It is suggested that teachers at the local level utilize this document in curriculum planning and interweave its contents with the local constraints formed by student ability, facilities, and administrative support.

Content and activities are suggested throughout the guide which will provide experiences for all students to better understand materials and processes and their utilization by industry and the resultant effects of their use on consumers. This particular guide has been developed in depth. Projects that integrate a variety of materials and processes are recommended; ideas for such projects are given in the sections on resources and supporting media and experiments, activities, and projects.

The original content for the guide was specified through the competency catalog developed for Materials and Processes Technology. It provides both the teacher and student with several options for developing the stated competencies. Each unit (content/concept) contains competency tasks, criterion reference measures, topics, a teacher's guide, student's performance guides, resources/media, equipment, and supplies. If one were to view the typical sequence of events in a unit of study, it would take on the character as displayed in the following diagram (Figure 1).

SUGGESTED FLOW OF ACTIVITIES
IN A TYPICAL UNIT OF STUDY
(PLASTICS)



NOTE: Using a multiple activities approach will require that groups of students engage in different activities, but reading, demonstrations, and discussions can include entire classes.

Figure 1

By developing a program of this nature at the local level, teachers of industrial arts can better assist in preparing learners for their life after school. Such a program will provide an opportunity to assist students in making decisions about their future careers and consumer products in their society.

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VIRGINIA INDUSTRIAL ARTS CURRICULUM

WHAT IS INDUSTRIAL ARTS

Since the American culture is distinctly characterized as industrial and/or technological, it becomes the function of schools to give every student an insight and understanding of the technological nature of the culture.

Given the individual's native potential for reasoning and problem-solving, imagining and creating, contructing and expressing with materials--from which technology and industry spring--this rich potential should be developed into fundamental study for all persons regardless of educational goal or occupational pursuit.

INDUSTRIAL ARTS CAN HELP THE STUDENT TO:

* gain an understanding of industry and technology
* discover interests and talents
* develop techniques in problem solving
* develop basic skills in the safe use of tools and machines
* make informed and meaningful occupational choices
* acquire interests in avocational pursuits and hobbies
* develop safe working habits
* apply other school subjects
* become a wiser consumer
* develop creativity
* develop pride in work well done
* work cooperatively with others

MISSION OF INDUSTRIAL ARTS EDUCATION

The mission of Industrial Arts Education is to assist each student to develop understanding about all aspects of industry and technology and aid in the discovery and development of individual potential.

GOALS

Consistent with their abilities, interests and educational needs:

1. Students at the elementary school level will receive learning reinforcement, through the use of simple tools, materials and processes, that contribute to personal development and technological awareness.

2. Students at the middle or junior high school level will be aware of employment and or self-employment opportunities and requirements for use in making career choices and in determining their educational programs.

3. Students at the senior high school level will acquire a technical adaptability yielding responsible citizenship through an occupational readiness, consumer preparedness, and personal enrichment.

4. Students participating in the Industrial Arts student organization (AIASA) will develop leadership abilities and will exhibit pride in work well done, high standards of craftsmanship, scholarship and safety.

CONTINUING INSTRUCTIONAL OBJECTIVES

The Industrial Arts program stresses the following instructional objectives:

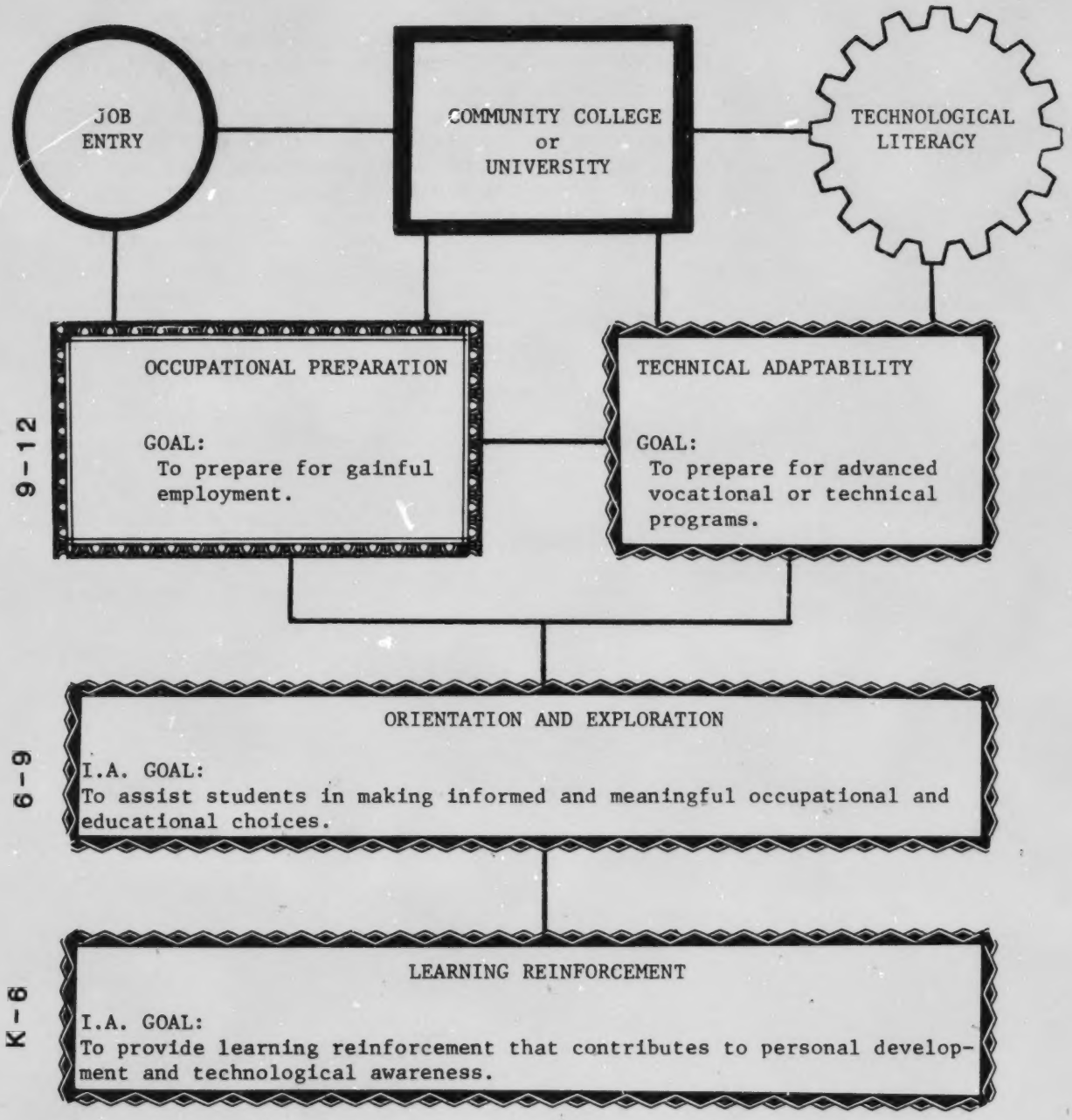
1. To develop in each student an insight and understanding of technology and industry and their place in our society and the free enterprise system.

2. To discover and develop individual talents, attitudes, interests and potentials as related to industry and technology.

3. To develop technical problem-solving skills related to materials and processes.

4. To develop in each student basic skills in the safe use of the common tools and machines.

INDUSTRIAL ARTS ARTICULATION MODEL



Industrial Arts ≈≈≈ Occupational Education

HIGH SCHOOL INDUSTRIAL ARTS — GRADES 9-12

DESCRIPTION

The Industrial Arts senior high school program is technical in nature. While it is designed to provide a foundation for career preparation either at the secondary or post-secondary level, it gives students a characteristic of adaptability which results in consumer preparedness, personal enrichment, as well as an occupational readiness. The program complements the middle or junior high school curriculum and offers sequential courses without repetition. Instructional focus is upon:

- Preparing for enrollment in advanced technical or occupational programs;
- Understanding industry, its place in society and the free enterprise system;
- Understanding industrial processes and the practical application of scientific principles;
- Developing basic skills in the proper use of common industrial tools, materials and processes;
- Problem-solving involving the materials, processees and products of industry.

GOAL

TECHNICAL ADAPTABILITY

To prepare students for advanced vocational and technical education programs.

STANDARDS

To accomplish this purpose the high school Industrial Arts program (grades 9-12) shall provide:

1. Exploration of Industrial Practices
   Experiences in laboratories will develop individual skill and creative abilities in the proper use of industrial tools, machines, materials, processes and products.

STANDARDS (Cont.)

2. Preparation for Advanced Training
Experiences and instruction in laboratories will prepare individuals for entry into advanced occupational or technical education programs.

3. Occupational Information
Occupational information, observations and instruction should assist individuals to discover and develop talents, interests, attitudes and potential related to industry and technology.

4. Guidance and Counseling
Vocational guidance and counseling should assist students in making informed and meaningful career choices and in arranging for placement in occupational programs.

5. Co-Curricular Student Organization
The Industrial Arts student association (AIASA) activities shall be provided as an active and integral part of the program.

6. Qualified Teacher
The teacher shall hold endorsement in Industrial Arts and have collegiate preparation through in-service or pre-service to implement the specific program assigned.

7. Appropriate Teaching Load
The student-teacher ratio should not exceed 20 to 1. An assignment of five periods daily shall constitute one full-time instructional load.

8. Facilities
All instructional laboratories, equipment and tools shall be adequate for safe, orderly and effective instruction.

9. Equipment
Laboratory equipment shall be compatable with the activities of the course.

10. Instructional Supplies
Consumable instructional supplies shall be provided to adequately accommodate each student's needs within the scope of the course enrolled.

STANDARDS (Cont.)

11. Appropriate Instructional Time and Level
Instructional time shall equal thirty six (36) weeks one period per day or 180 class hours. Offerings are provided at the high school level, grades 9-12, excluding junior high school.

12. Approved High School Courses
Phase I (Grades 9-12)
- Basic Technical Drawing
- Communication Technology
- Materials and Processes Technology
- Power and Transportation Technology

Phase II (Grades 10-12)
- Architectural Drawing
- Electricity and Electronics Technology
- Energy and Power
- Engineering Drawing
- Graphic Communications
- Metals Technology
- Woods Technology

THE STUDENT ORGANIZATION

DESCRIPTION

The Virginia Association of the American Industrial Arts Student Association (AIASA) supports students in learning to live in a technical world through an emphasis upon:

Democratic awareness and practices including both leadership and followership activities.

Exhibition of student performance, craftsmanship, and safety.

Involvement with the community's industrial and technical resources.

AIASA activities in the elementary school are provided as an extracurricular function. The middle or junior high and high school programs include AIASA within the instructional activities.

GOAL

LEADERSHIP/CITIZENSHIP DEVELOPMENT

To assist students develop leadership qualities, high standards of craftsmanship, scholarship, and safety.

STANDARDS

To accomplish this purpose the AIASA Chapter in the secondary school shall provide:

1. Integrated Activities
   Chapter activities as an integral part of the instructional program and supervised by Industrial Arts personnel;

2. Community Resources
   Individuals with opportunities to include community resources in Industrial Arts activities;

3. Participatory Democracy
   Experiences in parliamentary procedures and democratic decision making;

4. Recognition of Achievement
   Recognition for student performance, craftsmanship, and safety.

INDUSTRIAL ARTS PROGRAM OF STUDIES

LEVEL	GOAL	PROGRAM
Elementary School	Learning Reinforcement	Industrial Arts activities integrated within the elementry curriculum
Middle or Junior High School	Orientation and Exploration	Exploring Technology Modern Industry Construction Manufacturing
High School	Technical Adaptability	Phase I Basic Technical Drawing Communication Technology Materials and Processes Technology Power and Transportation Technology Phase II Architectural Drawing Electricity and Electronics Technology Energy and Power Engineering Drawing Graphic Communications Metals Technology Woods Technology

MATERIALS AND PROCESSES TECHNOLOGY

FOREWORD

Materials and Processes Technology is a senior high school Industrial Arts course specially designed to assist students in making informed and meaningful educational and occupational choices and to prepare them for advanced technical or vocational programs in a cluster of occupations related to materials and processes.

This is one of a series of Industrial Arts courses contributing to the broad mission of industrial arts in Virginia. These courses are to be offered in the early years of the senior high school in time for students to follow this experience with additional technical or occupational programs. Typical technical and occupational follow-up for materials and processes technology would be in the high school offerings of woods technology and metals technology; community college offerings of drafting and design, manufacturing or mechanical technology, materials science technology, construction technology, and pre-engineering technology; and university offerings of engineering, materials science, and industrial/engineering technology.

The major purpose of this guide is to assist the industrial arts teacher to implement a comprehensive Materials and Processes Technology program at the technical level in the high schools in Virginia. The publication of this instructional resource guide resulted from a contract awarded to the Department of Vocational and Technical Education at Old Dominion University by the Industrial Arts Education Service, Department of Education, Commonwealth of Virginia.

COURSE DESCRIPTION

Students study industrial/technical materials and processes as they fabricate usable products and conduct experiments. Learning experiences include using tools and equipment related to analysis, testing and processing metals, plastics, woods, ceramics, and composite materials plus career analysis. Recommended course for students interested in technical careers and other students interested in improving their consumer knowledge and technological literacy.

COURSE GOALS

Experiences and activities of this INDUSTRIAL ARTS course will enable the student to:

1.1 recall the basic nature, classifications, and properties of plastics, metals, woods, ceramics, composites, and other materials;

1.2 conduct research and experimentation and engage in development activities

1.3 explain the industrial processes employed to fabricate, test, and control quality of products and systems;

1.4 identify career paths for a selected field related to materials and processes technology;

1.5 determine potential career opportunities in fields related to materials and processes technology;

1.6 investigate and analyze industrial materials on the ecological balance, the utilization and conservation of natural resources, and the recycling and energy efficiency of industrial materials and products;

2.1 demonstrate problem-solving techniques in selection of suitable materials and processes for fabricating various products;

2.2 demonstrate proficiency of metalworking, woodworking, plastics, ceramics, and testing tools and machines;

2.3 use Systems International and customary units of measure in layout, inspection, machinery, and testing;

2.4 analyze the nature of materials and the types of machine and tool operations to use on materials;

2.5 produce useful products with such materials as metals, woods, plastics, ceramics, and composites;

3.1 appreciate the knowledge, skills, and aptitudes required for different levels of employment in fields related to materials and processes technology;

3.2 exhibit good work attitudes and habits and shows respect for and cooperation with associates;

3.3 foster safe working attitudes and habits in class and throughout daily living.

SUGGESTED OUTLINE FOR CONTENT/CONCEPTS AND TOPICS

Integration of certain topics throughout the course is desirable. For instance, Topic 1--Materials and Processes Technology--should receive continual emphasis, i.e., while studying plastics, focus on safety, careers and career preparation for the plastics industry, nature and properties, environment and energy concerns, consumer tips, and technological advancements. Rather than making separate projects for each material, one may prefer to combine several materials in products; however, study each material for its special methods of processing.

1 - Materials and Processes Technology
- 1.1 Introduction to Materials and Processes
  - a. The Study of Materials
  - b. Materials Processing
  - c. The Environment, Energy, and Safety
  - d. Consuming Materials
  - e. Technological Advancement
- 1.2 Value of Studying Materials and Processes

2 - Safety Procedures
- 2.1 Safety
- 2.2 First-Aid

3 - Industrial Technology Careers
- 3.1 Careers Related to Materials
- 3.2 The Engineering Team

4 - In-class Industrial Arts Student Association
- 4.1 A.I.A.S.A.

5 - Nature of Materials
- 5.1 Atomic Structure
- 5.2 Micro/Macrostructure
- 5.3 Sources of Materials

6 - Classification of Materials
- 6.1 Family of Materials
- 6.2 Metals
- 6.3 Polymers
- 6.4 Ceramics
- 6.5 Composites
- 6.6 Material Selection

7 - Properties of Materials
- 7.1 Chemical Properties
- 7.2 Physical Properties
- 7.3 Mechanical Properties
- 7.4 Materials Testing

8 - Materials Processing
- 8.1 Product and Systems Design
- 8.2 Custom and Mass Production
- 8.3 Measurement and Layout
  - a. S. I. Metric Measure
  - b. Conventional Measure
  - c. Tools
- 8.4 Inspection and Quality Control

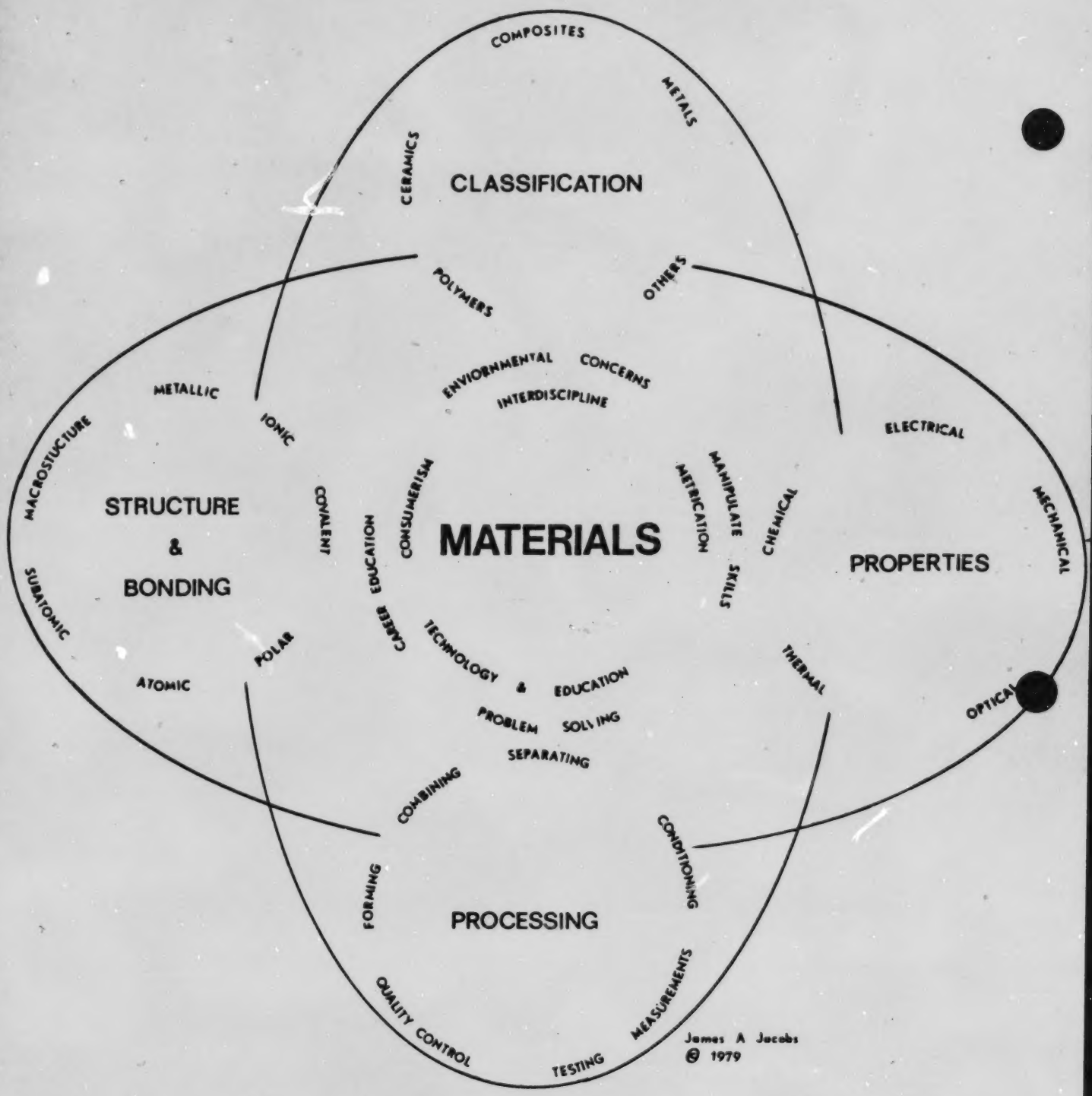
9 - Plastics
- 9.1 Nature of Plastics
- 9.2 Properties of Plastics
- 9.3 Combining
- 9.4 Forming
- 9.5 Separating
- 9.6 Conditioning
- 9.7 Industrial Applications

10 - Metals
- 10.1 Nature of Metals
- 10.2 Properties of Metals
- 10.3 Forming
- 10.4 Separating
- 10.5 Combining
- 10.6 Conditioning
- 10.7 Industrial Applications

11 - Woods and Forest Products
- 11.1 Nature of Woods
- 11.2 Properties of Woods
- 11.3 Separating
- 11.4 Combining
- 11.5 Conditioning
- 11.6 Industrial Applications

12 - Ceramics
- 12.1 Nature of Ceramics
- 12.2 Properties of Ceramics
- 12.3 Processing Ceramics
- 12.4 Industrial Applications

13 - Composites
- 13.1 Nature of Composites
- 13.2 Properties of Composites
- 13.3 Processing Composites
- 13.4 Industrial Applications



MATERIALS AND PROCESSES TECHNOLOGY MODEL

KEY TO GUIDE USAGE

The units of study in this guide are broken into major divisions entitled Content/Concept. The content and concepts are dealt with through the specification of Tasks which students will be competent to achieve plus the Criterion Reference Measures used to evaluate the Tasks. The Teacher's Guide provides suggestions for the teacher to follow in providing activities to insure that students can master the tasks. The Student's Performance Guide indicates the types of activities students perform; all students will probably not perform each performance listed and may do other activities.

The numbering system used in the guide ties together units, content/concepts, topics, teacher's guide, and student's guide. For example, all content/concepts dealing with plastics are assigned a number 9. The six concepts on plastics each have the numerical designation, i.e., 9.1 Nature of Plastics, 9.2 Properties of Plastics, 9.3 Combining Plastics, etc. The Tasks and Criterion Reference Measures have numbers to correspond to the Content/Concept number for which they deal. Each Content/Concept is further broken into Topics which reflect corresponding numbering, i.e., 9.3 Plastics-Combining has Topics 9.31 Casting, 9.32 Foaming, 9.33 Welding, 9.34 Adhesives, and 9.35 Fasteners. Thereafter, each Topic is indexed to the Teacher's Guide and Student's Performance Guide with corresponding numbers so that teachers can easily see what they and students can do to correspond with the topics.

The Resources and Media are keyed to alpha-numeric designations as are experiments and certain equipment and supplies. The alpha-numeric designation indicates the section in the Resources and Supporting Media part of this guide to locate the reference, e.g., P-23 is the twenty-third reference in the Polymer section. The key that follows matches letters to their section in the guide.

KEY FOR RESOURCES AND SUPPORTING MEDIA

G - General - references that cover careers and the broad topic of materials and processes.

N - Nature and Properties - references on classifications, structures, and properties plus related activities.

C - Ceramics - references on ceramics including pottery, concrete, and glass and related activities.

CO - Composites - references on composites and related activities.

M - Metals - references on metals and related activities.

P - Polymers - references on plastics, woods, and fibers and related activities.

PR - Processing - references on manufacturing measurement, finishing, machinery, welding, and adhesive bonding.

F - Fibers - films, filmstrips and slides on fibers and information on obtaining them.

R - Resource People - names of people and organizations who can assist the teacher.

S - Supplies and Equipment Sources - information on obtaining kits, supplies, and equipment that are listed with each unit.

L - Laboratory Equipment - names of equipment.

E - Experiments - step-by-step procedures and drawings for experiments, activities, and projects to use in the course.

A - American Industrial Arts Student Association - information on industrial arts student association activities.

The Sources of Information and Materials section lists a variety of organizations that provide free and inexpensive assistance to the educator. These include films and other media, technical information, career information, guest lectures, and general support.

UNITS OF STUDY

1. CONTENT/CONCEPT **MATERIALS AND PROCESSES TECHNOLOGY**

Tasks: 1.10 Gain an appreciation for the importance of technological developments related to materials and processes technology.
Criterion Reference Measure: Compile a list of at least five reasons showing the importance of technological advances in materials and processes technology.

1.20 Summarize the value of a study of materials and processes technology.
Criterion Reference Measure: List and discuss at least two reasons that a knowledge of materials makes a wise consumer and an intelligent citizen.

Topics: 1.1 Introduction to Materials and Processes
1.2 Value of Studying Materials and Processes

Teacher's Guide:

1.10 Discuss our dependency on a large variety of materials.

1.11 Show a film depicting production of a product such as an automobile and emphasize the many materials and processes involved.

1.12 Bring in articles from newspapers and periodicals such as Popular Science; Man, Society, and Technology; Industrial Education; Materials Engineering; and Modern Plastics to highlight developments in materials and processes and their effect on society.

1.20 Discuss the advantages of having a knowledge of materials to consumers.

1.21 Encourage reading in newspapers and magazines, e.g., Consumer Report that discuss product quality, unique or new applications of materials, and environmental concerns in materials, products, and use, e.g., formaldehyde foam insulation.

NOTE: The topical sequence followed in this guide is not dictated by the numerical sequence of tasks in the "Catalog of Tasks for Competency-Based Instruction in Materials and Processes Technology." An integration of topics should facilitate instruction with an end goal of students gaining competencies for the completion of each task.

Student's Performance Guide:

1.10 Discuss the importance of technological development in and related to materials and processes.

1.11 Compile a list of reasons favoring the importance of technological developments.

1.12 Present an oral or written report on "The Importance of Technological Advancement in Materials and Processes."

1.13 Analyze objects around the lab, classroom, home, and rest of the environment to note the wide variety of materials.

1.14 Discuss the reasons for enrolling in materials and processes technology, what type of activities are anticipated, and what new knowledge is expected to be gained.

1.15 Construct bulletin boards using magazine and newspaper cut outs.

1.16 Conduct research and present reports on selected materials or processes.

1.17 Listen to engineers, technicians, and scientists from such agencies as NASA's Langley Research Center or other governmental agencies and private businesses speak on current developments.

1.18 Take field trips to local industry and governmental facilities.

1.20 Examine products to determine the quality of craftsmanship, suitability of materials, safety, and compare costs.

1.21 Read about the uses of materials and problems related to materials such as scarcity, pollution, flammability, carcinogenics, durability, and insulating values of building materials.

1.22 Discuss the advantages of recycling materials such as paper, glass, aluminum, and steel.

1.23 Discuss the environmental problems caused by materials that are not biodegradable.

1.24 Conduct research into economic problems facing the United States because of our lack of raw materials such as chromium ore, tungsten, and oil.

1.25 View films on raw materials extraction or synthesis and effects on ecology, advances in materials technology, and recycling waste products.

Resources/Media

Introductory unit in books on materials and processes technology, e.g., *G-1. Show films such as:

* F-1, F-2, F-3, F-4, F-30, F-36, F-37, F-43, F-51, F-26 thru F-29
* R-1 or local industry
* G-4 "Rationale" at beginning of each unit
* See "Resources and Supporting Media" section

Equipment

16 mm movie projector
overhead

Tasks: 2.10 Wear appropriate clothing and protective devices and conduct safe laboratory experiments and processing operations.
Criterion Reference Measure: Using appropriate standards, demonstrate use of shop safety clothing, protective devices, and equipment, plus safe set up and operation of tools and equipment when constructing a project or conducting an experiment.

2.20 Recall first aid procedures in the event of an accident.
Criterion Reference Measure: List the first aid procedures to employ in the event of a laboratory accident.

Topics: 2.1 Safety
2.2 First-Aid

Teacher's Guide:

2.10 Prior to going into laboratory, present lecture on general safety.

2.11 Administer test to cover 2.10 requiring a set "mastery" score before students are allowed in laboratory.

2.12 Display safety posters and change on a regular basis.

2.13 Give test item questions on the safety poster.

2.14 Insure equipment is maintained in a safe operating condition.

2.15 Insist upon use of safety devices and protective clothing.

2.16 Assign readings related to safe operations when beginning a new topic involving new equipment and tools.

2.17 Mark off safety zones around equipment.

2.18 Invite speakers to discuss OSHA (Occupational Safety and Health Act).

2.20 Discuss first-aid steps to be followed in case of an accident.

NOTE: Caution is advised in first-aid instruction. First-aid is intended to prepare the students for <u>immediate</u> action following an accident. Check with supervisors and administration on appropriate instruction and procedures.

Student's Performance Guide:

2.10 Supplied with appropriate standards, demonstrate a safe working attitude at all times when in the laboratory.

2.11 Read safety related units in texts dealing with materials testing, woods, metals, plastics, ceramics, and chemical processing.

2.12 Perform laboratory experiments on materials processing using prescribed procedures.

2.13 Pass written safety test(s).

2.14 Pass proficiency tests on the operation of equipment.

2.15 Follow the rules of safe conduct in using equipment.

2.16 Elect a safety director to work with the instructor to monitor unsafe practices in the laboratory.

2.17 Be alert to the condition of laboratory equipment and report unsafe equipment and conditions to the instructor.

2.18 Listen to the instructor's lecture on first-aid procedures employed in laboratory accidents.

Resources/Media

Safety units in textbooks: P-23, M-5, P-17, C-3, CO-1 and others. Safety posters and signs. See "Resources and Supporting Media" section for books on each material.

Equipment

All laboratory equipment, heat and chemical protective gloves, goggles, heat protective apron and spats, machine guards, ventilation system, eye wash stations, fire extinguishers, and emergency shower.

Supplies

Check with administrators and school nurse about first-aid supplies.

3. CONTENT/CONCEPT **INDUSTRIAL TECHNOLOGY CAREERS**

Tasks: 3.10 Evaluate careers related to industrial materials including plastics, metals, woods, composites, and ceramics.
Criterion Reference Measure: Show an awareness of the career occupations available in the areas of plastics, metals, woods, composites, ceramics, and materials science.

3.20 Describe the members of an engineering team and summarize how they interact.
Criterion Reference Measure: Give a definition of each member of the engineering team and list typical job classifications.

Topics: 3.1 Careers Related to Materials
3.2 The Engineering Team

Teacher's Guide:

3.10 Assign reading on careers in engineering technology G-4 (Step C-1) and industrial arts education.

3.11 Test on G-4 objectives.

3.12 Instruct students on approaches for obtaining interviews and other career information.

3.13 Assign teams to decorate career bulletin boards.

3.14 Duplicate career information cards and distribute.

3.15 Encourage career discussions.

3.16 Invite in college professors to discuss career preparation.

3.17 Show films and filmstrips on careers.

3.18 Inform students about cooperative education in technology and engineering at the college level.

3.20 Invite speakers from government and industry to describe their work.

3.21 Lecture on the engineering team and fields of engineering.

3.22 Bring in Occupational Outlook Handbook.

3.23 Encourage the A.I.A.S.A. to set up engineering teams for service projects.

3.24 Assign students to develop a strategy of career preparation including steps to enter the career such as deciding what high school courses are needed, post secondary education (college, apprenticeship, etc.), determine which area colleges and industries provide post secondary preparation for their career, and study Occupational Outlook Handbook and other career information.

NOTE: Begin this topic in the initial classes then integrate throughout the course.

Student's Performance Guide:

3.10 Study information on careers in such related fields of industrial materials as mechanical engineering, materials science, plastics, woods, metal technology, and ceramics.

3.11 Perform interviews, job surveys, and job evaluations on careers related to industrial materials and processes.

3.12 Record and evaluate job data on information cards.

3.13 Discuss the various occupations and fields of specialization in your area of interest.

3.14 Develop career goals.

3.15 Draw a career lattice for your chosen field.

3.16 List the education and training required to enter and progress in a chosen career.

3.17 Invite guest speakers from industry and government to discuss career opportunities.

3.20 Identify members of an engineering team including designers, engineers, supervisors, managers, craftsmen, technicians, scientists, and technologists.

3.21 Read material and listen to instruction on the structure of the engineering team.

3.22 Study the Occupational Outlook Handbook on careers for members of the engineering team.

3.23 Organize in-class engineering teams to perform enterprising or service projects.

Resources/Media

G-4 Module on Careers,
G-2, G-3, G-8, G-9, G-10,
F-5, R-2, P-17

Supplies

Synchronized sound filmstrip
projector

4. CONTENT/CONCEPT **IN-CLASS INDUSTRIAL ARTS STUDENT ASSOCIATION**

Task: 4.10 Participation (involvement) in a democratic organization with activities associated with materials and processes technology.
Criterion Reference Measure: Take part with other class members in organized activities providing leadership, industrial/community resources, school/community services, product/service enterprises, and achievement recognition.

Topic: 4.1 A.I.A.S.A.

Teacher's Guide:

4.10 Explain the purpose and goals of an industrial arts student association.

4.11 Review prior activities of other A.I.A.S.A. clubs sponsored by the instructor.

4.12 Discuss and assist with leadership development activities which should be employed by the student association. Establish student responsibilities, i.e., safety, clean-up, etc.

4.13 Explain and assist with industrial/community resource activities for the materials and processes technology program.

4.14 Define the role of the class in school/community service projects and assist in their accomplishment.

4.15 Provide shadow experiences for students.

4.16 Organize and operate a product/service enterprise.

4.17 Encourage competition in materials and processes activities to motivate and recognize achievement.

NOTE: The content of this unit should be reviewed early in the course and emphasized as an integral component throughout the course.

Student's Performance Guide:

4.10 Organize a personnel system which uses A.I.A.S.A. class officers to manage class routines.

4.11 Officers conduct class meetings to organize classroom activities.

4.12 Announce and pre-register class members for A.I.A.S.A. conferences and leadership workshops.

4.13 Utilize committees to work as research teams or as a materials processing corporation.

4.14 Community Resources Committee arranges for speakers on materials and processes.

4.15 Students survey and/or interview materials and processes technology personnel in the community.

4.16 Students organize tours to materials and processes technology firms.

4.17 Industries are encouraged to donate unused materials and sample products to the school.

4.18 Service Committee suggests projects needed by the school or community.

4.19 Energy conservation ideas demonstrated to the school and/or public.

4.20 Demonstrate ways to conserve or recycle materials.

4.21 Demonstrate consumer information or simple checks to use in product selection.

4.22 Enterprising Committee suggests products or services for class to utilize to raise funds.

4.23 Manufacture a student product to raise funds.

4.24 Provide technical assistance through service activity to others for a set fee.

4.25 Contract with another group to solve technical problems for a fee.

4.26 Recognition Committee suggests a materials and processing technology contest as a learning activity for class members.

4.27 Pre-register student projects for Spring Festival.

4.28 Organize an open house to recognize student work.

4.29 Present awards for craftsmanship, design, and creativity for materials and processes technology projects.

4.30 Create a contest related to the course for students in the school to enter (i.e, material strength of a bridge).

Resources/Media
A-1 through A-58

Equipment
Overhead projector, slide projector, and movie projector

5. CONTENT/CONCEPT **NATURE OF MATERIALS**

Tasks:

5.10 Explain the basic structure of atoms and ions.
Criterion Reference Measure: Construct or draw an atom model.

5.20 Relate microstructure and macrostructure to the make-up of industrial materials.
Criterion Reference Measure: Sketch examples of crystalline and amorphous structures.

5.30 Identify the sources of raw materials and recall methods of obtaining materials.
Criterion Reference Measure: List typical methods of obtaining raw materials that involve mining, refining, harvesting, and chemical synthesis.

Topics:

5.1 Atomic Structure
5.2 Micro/Macrostructure
5.3 Sources of Materials

Teacher's Guide:

5.10 Assign G-4 (Step 0-1).

5.11 Test on G-4 objectives.

5.12 Provide kits to build models of body centered cubic, face centered cubic, and hexogonal closed packed lattices.

5.13 Refer to N-1, pgs. 8-14 and pgs. 57-58, Experiment II B.

5.14 Show F-6 and follow-up with discussion.

5.20 Show grains in metals through photomicrographs (F-7), metallurgical microscope (S-5)* and galvanized sheet metal.

5.21 Discuss terms and concepts in Step 0-1.

5.22 Set up teams to grow crystals (Step 0-1).

5.30 Post and discuss F-10, F-11, F-12, and refer to M-1 and P-3 on methods of obtaining raw materials such as mining, refining, forestry, and chemical synthesis.

5.31 Allow teams to make and test paper per E-1 and P-4.

5.32 Show F-13 and assign P-3.

5.33 Assign research projects.

5.34 Arrange field trip to plants where raw materials are processed.

5.35 Order free display samples of crude oil in various intermediate streams and products, N-21.

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*Students may polish and etch specimens. Caution in the use of acids. Refer to M-3, pp. 29-32.

NOTE: Introduce new terms, their pronunciation, and definition at the beginning of each class.

Student's Performance Guide:

5.10 Define and/or identify atoms, nucleus, valence electron, protons, and ions of the Bohr model.

5.11 Draw a three dimensional sketch or construct a model of styrofoam balls representing the Bohr model atom.

5.12 List the three types of primary atomic bonds basic to solid materials, and cite one example for each that exists in common materials.

5.20 Sketch the structure of a typical amorphous material and a crystalline material.

5.21 Define the terms matter, material, substance, compound, mixture, solution, solid, homogenous, organic, and inorganic.

5.22 Sketch the formation of grains as they solidify from the molten state.

5.30 Listen to instructor's lecture concerning the various methods of processing raw materials.

5.31 Visit a material processing plant.

5.32 Write film reviews involving processing of raw materials.

5.33 Develop a research paper on such topics as mining, refining, forestry, or chemical synthesis.

Resources/Media

G-4, N-1, M-2, F-6, F-7, F-8, F-10, F-11, P-3, P-4, N-8, F-30, F-43, N-21

Equipment

metallograph w/Polaroid camera attachment, 16 mm film projector, slide projector, Handimet abrasive surfacer (L-2), natural gas supply, bunsen burners, Polaroid camera, periodical chart (wall)

Supplies

one-inch styrofoam balls, pipe cleaners, galvanized sheet metal, photomicrographs (F-7), Buehler metallurgical specimens (S-5), wet or dry aluminum oxide paper (grits: 100, 240, 320, 400, 600), specimen etchants (S-6), table salt, 250 ml pyrex beaker, string, ¼" hex nut, 1/8" dowel rod, ASM experiment II-B (S-3), 12-petri dishes, see E-1, Polaroid film

6. CONTENT/CONCEPT CLASSIFICATIONS OF MATERIALS

Tasks:

6.10 Recall the four main groups of the family of industrial materials.
Criterion Reference Measure: Cite examples of materials for each of the four family groups.

6.20 Define metals and differentiate between various metals.
Criterion Reference Measure: Give one definition of a metal and explain the difference in ferrous and non-ferrous metals and alloys.

6.30 Define non-metals in terms of raw materials and basic structure.
Criterion Reference Measure: List basic elements and illustrate the structure of polymers, ceramics, and composites.

6.40 Recognize the value of individual materials.
Criterion Reference Measure: Select at least three materials for a product.

Topics:

6.1 Family of Materials
6.2 Metals
6.3 Polymers
6.4 Ceramics
6.5 Composites
6.6 Material Selection

Teacher's Guide:

6.10 Assign reading G-4 (Step O-2).

6.11 Test on G-4 objectives.

6.12 Ask students to bring in old objects for disassembly.

6.13 Establish teams to examine materials for specific gravity (N-7, p. 22), texture, magnetism, etc.

6.20 Show students metal specimens and discuss metals, alloys, ferrous and non-ferrous metals. Separate by a magnet.

6.30 Assign activities in G-4.

6.31 Assign activity P-31.

6.32 Demonstrate the nature of thermoplastics, thermosets, and elastomers.

6.40 Discuss ceramic materials.

6.50 Show examples of common composite materials.

6.60 Assign a project that uses at least three materials such as woods, metals, and plastic.

6.61 Write to companies for subscriptions to free periodicals (N-10 thru N-15). They provide interesting news on new materials and processes developments.

6.62 Show films on various materials and how they are obtained and processed.

6.63 Allow students to select from a variety of projects in which they select the materials. Require them to justify their choice.

6.64 Assign a mass production project incorporating at least three different materials.

6.65 Discuss the concept of materials systems commonly found in products and buildings; e.g., an auto tire is a material system composed of many materials that complement each others properties.

NOTE: Introduction to basic tools and their use would integrate well here.

Student's Performance Guide:

6.10 Read information on the classification of industrial materials.

6.11 Dissassemble common products such as light bulbs, household fuses, clocks, toys, or switches and place them in family groups on display board.*

6.12 Examine various materials within each group to determine similiarities and differences in macrostructure, e.g., different woods, plastics, metals, etc.

6.20 Distinguish metals from alloys and ferrous metals from non-ferrous metals.

6.21 Process metals in experiments and on projects.

6.30 Diagram monomers, polymers, thermosetting networks, thermoplastic structures, and the molecular structure of elastomers.

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* Save these displays for discussions on properties of materials and manufacturing processes.

6.31 Examine specimens of natural and synthetic polymers, ceramics, and composites.

6.32 Produce elastomer products.

6.33 Process non-metals in experiments and on projects.

6.40 Construct a project using at least three different materials in a manner that exploits each materials advantages.

Resources/Media

G-4, F-7, N-7

Equipment

triple beam balance, oven, bench metallograph, materials processing center (L-4) 16 mm projector

Supplies

specimens of ferrous and non-ferrous metals, magnet, Buehler metallographic specimens (S-5), Plastics School Specimens (S-12), tall glass cylinder, e.g., 500 cc. graduated glass cylinder (S-8 thru S-11), 6" ruler, wood specimens, e.g., white pine, southern pine, oak, and aspen (S-16 thru S-19). Project materials determined by type of project, e.g., latex and room temperature vulcanizing rubber (RTV), urethane foam (S-12 thru S-19).

7. CONTENT/CONCEPT **PROPERTIES OF MATERIALS**

Tasks: 7.10 Recall the basic nature of corrosion/oxidation.
Criterion Reference Measure: List three conditions which cause rust in ferrous metals and corrosion/oxidation of non-ferrous metals and polymers.

7.11 Determine how to increase corrosion/oxidation resistance.
Criterion Reference Measure: Select the proper protective finish or combination of metals to prevent corrosion.

7.20 Recall typical physical properties of materials.
Criterion Reference Measure: Define the electrical properties of conductivity, resistivity, and dielectric strength and thermal conductivity and expansion.

7.30 Recognize conditions that cause stress.
Criterion Reference Measure: Diagram tensile, compressive, shear, and torsional stress.

7.31 Measure common mechanical properties.
Criterion Reference Measure: Test material specimens for hardness, toughness, tensile, compressive, shear and torsional strength.

7.40 Differentiate between destructive and non-destructive testing.
Criterion Reference Measure: Define static and dynamic testing and give two examples of non-destructive tests.

Topics: 7.1 Chemical Properties
7.2 Physical Properties
7.3 Mechanical Properties
7.4 Materials Testing

Teacher's Guide:

7.10 Assign reading G-4 (Step 0-3).

7.11 Test on G-4 objectives.

7.12 Show film F-14.

7.13 Experiments 9 and 10 in N-8 on pages 29-34, and N-9.

7.14 Discuss protective coatings for metals.

7.20 Experiments in G-4 (Step 0-1).

7.21 Experiments E-3 through E-8 in this guide.

7.30 Assign teams to conduct tests on the universal testing machine (e.g., N-10, Experiments 4-21 and E-24).

7.31 Allow teams to construct testing devices and conduct tests. (See plans under Experiments, Activities, and Projects E-9 through E-13 and in references G-4, N-7, N-17, P-13.

7.32 Challenge students to design and construct a product/system using the knowledge of the nature of materials (See outline E-2).

7.40 Discuss the objectives of destructive and non-destructive testing (NDT).

7.41 Demonstrate the testing of a bicycle innertube in a tub of water as an example of NDT.

7.42 Demonstrate dye penetrate inspection techniques.

NOTE: After an introductory unit on this topic, it integrates well into other units.

Student's Performance Guide:

7.10 Demonstrate the nature of corrosion/oxidation of materials.

7.11 Observe instances of rust on ferrous metals, corrosion of nonferrous metals, and oxidation of polymers.

7.12 Prepare a display of objects and pictures of corroded/oxidized objects.

7.13 Study methods for preventing corrosion such as protective coatings, pickling, insulation, and material selection.

7.14 Use protective coatings in project construction.

7.15 Prepare specimens of metals, plastics, wood, rubber, ceramics and composites in various conditions with and without protective coatings, then mount on roof for long exposure.

7.20 Conduct tests of thermal expansion, thermal conductivity, and electrical conductivity.

7.21 Distinguish between heat and temperature and use both S. I. (Systems International) and customary units to measure heat.

7.30 Calculate stress for a given load on a given cross section using S. I. (Systems International) and customary units.

7.31 Use a testing machine to test tensile strength, shear strength, compressive strength, toughness, elasticity, and hardness.

7.32 Construct testing devices to measure mechanical properties.

7.33 Stress specimens for elastic and plastic deformation.

Resources/Media

G-4, N-8, F-14, N-9, N-7, N-10, PR-2

Equipment

See N-8 and N-9, universal testing machine w/attachments or mechanics of materials learning system (L-3), portable hardness tester, hot plate, bunsen burner, volt-ohm millimeter, flammable storage cabinet, refrigerator

Supplies

See list in N-8 and N-9. Tensile specimens--cold-rolled steel, wrought aluminum, wrought brass, cast iron, and cast aluminum. Bar specimens (1" x 1" x 13")--aluminum, cold-rolled steel, and hardened steel. Compression test specimens--hot and cold rolled steel, wrought aluminum, yellow brass, gray iron, concrete (2" dia. x 4"), and various wood (1" x 1" x 4"). Shear specimens (3/8" dia. rod)--steel, brass, and aluminum.

Hardness specimens--cold and hot rolled steel, hardened steel cast iron, and wrought aluminum. Wooden beams (2" x 4" x 28"). Columns--cold rolled steel (1/4" dia.--2" long, 4" long, 10" long); steel conduit (1/2" dia. x 8"), wood (7/8" x 7/8" x 8"), hot rolled steel (5/16" dia. x 8"). Also see specimens available with L-3. Mohs hardness kit (S-11). Other specimens and supplies depend upon experiments and devices selected from E-2 through E-12.

8. CONTENT/CONCEPT **MATERIALS PROCESSING**

Tasks:

8.10 Describe how a product or system is engineered and manufactured.
Criterion Reference Measure: Explain the activities of the engineering team in research, development, and design.

8.20 Differentiate between custom and product design.
Criterion Reference Measure: Produce products through custom production techniques and mass production techniques.

8.30 Use basic measuring and layout tools.
Criterion Reference Measure: Read S. I. metric and customary units in layout work on projects and in conducting experiments.

8.40 Explain how standards are maintained in manufacturing.
Criterion Reference Measure: Define inspection and quality control and list at least two techniques for each.

Topics:

8.1 Product and Systems Design
8.2 Custom and Mass Production
8.3 Measurement and Layout
8.4 Inspection and Quality Control
8.5 Processing Materials

Teacher's Guide:

8.10 Assign G-4 (Step C-1) and other reading on product or system engineering.

8.11 Form engineering teams to conduct engineering and manufacturing activities.

8.20 Allow students to produce individual custom projects and mass produced projects.

8.21 Let A.I.A.S.A. group raise funds or perform a service with mass production techniques.

8.30 Instruct students in the use of basic layout and measurement tools.

8.31 Assign reading in PR-2.

8.32 Show films on S. I. metrics.

8.33 Test on skills in measuring with S. I. and customary units.

8.40 Discuss the purpose of inspection and quality control in manufacturing.

8.41 Assign students jobs as inspectors with mass production activity.

8.42 Select a paragraph and ask each student to count the number of the letters "f" in the paragraph. Use the variation in answers to discuss the problems in inspection and quality control.

8.43 Invite guest speakers from government and industry to discuss inspection, quality control, warranties, consumer rights and safety standards.

8.44 Discuss productivity and how it has dropped in the U.S. while going up in Japan. How does this affect the average U.S. citizen? What can be done to improve worker productivity in the U.S.?

8.50 Provide an overview of methods of processing materials.

NOTE: This unit of study is intended as an overview of the content and concepts to follow. Do not consume too much time on any topic at this time since detailed study can come later.

Student's Performance Guide:

8.10 Read and discuss the procedures involved in engineering and manufacturing a product or system.

8.11 Work as a member of the engineering team in production of a product or system.

8.12 Design products or systems.

8.13 Use orthographic projection and make working drawings of a project or system complete with bill of materials.

8.20 Make projects using custom production techniques.

8.21 Make projects using mass production techniques.

8.30 Measure various quantities of materials and conduct tests using S. I. units and customary units.

8.31 Design and construct products using all S. I. metric units.

8.40 Serve as an inspector on a production team.

8.41 Read about the role of inspection and quality control in industry.

8.42 Given a paragraph by the instructor, count the number of the letters "f" in the paragraph. Use the chalkboard to draw a line graph of each person's count. Use this to discuss the problems in inspection and quality control.

8.43 Study about the U.S. National Bureau of Standards, Underwriters Laboratory, American Society of Testing and Materials, American National Standards Institute, and similar standards organizations.

8.44 Discuss warranties and consumer protection agencies.

8.45 Listen to guest speakers discuss standards, consumer rights, and warranties.

Resources/Media

G-4, PR-5, PR-6, PR-2,
See S. I. metric media pp. 52-59
in PR-2, R-3, R-4, R-5, R-6

Equipment

try-squares, combination square, scribers, dividers, steel tape, micrometers, dial indicators, depth gauges, steel rules, screw pitch gauges, glass and plastic graduates, thermometer (high temperature), vernier calipers, go-not-go gages, drafting equipment (compass, triangles, drafting machines with scales, drafting tables)

NOTE: Where practical, order S. I. and customary units.

Supplies

See PR-2 (p. 51) for S. I. supplies.

9. CONTENT/CONCEPT **PLASTICS - NATURE AND PROPERTIES**

Tasks: 9.10 Describe the structure of plastics and synthesis processes.
Criterion Reference Measure: Sketch thermoplastic and polymer structures; explain addition and condensation polymerization.

9.20 Recall common properties of plastics.
Criterion Reference Measure: Define outdoor weatherability, thermal properties, visco-elasticity, chemical resistance, electrical and mechnical properties.

Topics: 9.1 Nature of Plastics
9.2 Properties of Plastics

Teacher's Guide:

9.10 Assign G-4.

9.11 Test on G-4 objectives, show F-16, F-17.

9.12 Supply polymer model kits.

9.13 Write to makers of plastics and request free specimens, descriptive literature, and films.

9.14 Assign a team to conduct a demonstration in the synthesis of nylon (E-14).

9.20 Have students conduct test to identify plastics (p. 33).

9.21 Assign teams to test physical, chemical, and mechanical properties (G-4, Step P-2).

9.22 Order free copies of P-34.

NOTE: Refer back to Topics 1.0, 2.0, and 3.0 to integrate here.

Student's Performance Guide:

9.10 Read about the nature of plastics.

9.11 Take test on the nature of plastics.

9.12 Construct models of monomers and polymers.

9.13 Calculate the molecular weight of polymers.

9.14 Take field trips to plastics companies.

9.15 Conduct experiments or construct projects to differentiate between thermosetting plastics and thermoplastic plastics.

9.16 View films on synthesis of polymers.

9.17 Synthesize nylon fibers.

9.18 Conduct test to identify plastics.

9.20 Conduct test on physical, chemical, and mechanical properties of plastics.

9.21 Select plastics in designing a project or as a consumer of products.

Resources/Media

G-4, P-23, P-33, P-34, F-16, F-17, F-18, E-14, S-8, S-9, S-10, S-11

Equipment

16 mm projector, slide projector with synchronized tape player, natural or bottle gas, bunsen burner, tongs, heat protective and chemical protective gloves, goggles, apron, flammable waste containers, mechanics of materials learning system (L-3) or Universal testing machine, materials processing center (L-4), high temperature thermometer, stop watch, high temperature oven.

Supplies

See E-14 (available from S-7), plastic stock and scrape; acrylics, polyethylene, nylon, urethane, epoxy, acetals, ABS, polyesters, styrenes, cellulose acetate, silicon, PVC (See S-12 thru S-13), molecular model kits (S-8 thru S-10), rags

9. CONTENT/CONCEPT **PLASTICS - COMBINING**

Task: 9.30 Produce plastics through combining.
Criterion Reference Measure: Conduct experiments and make plastic parts by casting, foaming, welding, adhesives, and fasteners.

Topics: 9.30 Combining
9.31 Casting
9.32 Foaming
9.33 Welding
9.34 Adhesives
9.35 Fasteners

Teacher's Guide:

9.30 Discuss commonalities of combining materials and the effects of a catalyst.

9.31 Use P-23 as students guide for processing plastics.

9.31.2 Project ideas are in P-24, P-26, P-31, P-32

9.31.3 Discuss safety precautions in handling plastic resins.

9.31.4 Provide dyes for coloring castings.

9.32.1 Demonstrate foaming of plastics.

9.32.2 Provide plans for foamed plastics projects.

9.32.3 Discuss applications of foamed plastics.

9.33 Demonstrate plastic joining with hot gas welding and solvent fusion.

9.34 Discuss the problems in selecting adhesives for plastics.

9.35.1 Introduce mechanical fasteners, cutting lubricants, tapping and threading.

9.35.2 Discuss the differences in fasteners used on plastics and other materials.

NOTE: The processing of each material by every process may not be practical, but through instructor demonstration and observation all students can gain exposure and grasp each processing concept.

Student's Performance Guide:

9.30.1 Read about and discuss types of catalyst and how they cause reactions.

9.30.2 Mix resin and catalyst and produce plastic casting.

9.30.3 View films on combining plastics.

9.31.1 Use dyes to color plastic casting.

9.31.2 Mix water extended polyester resins and cast them.

9.31.3 Observe safety precautions in combining plastics.

9.32.1 Combine resin and catalyst to produce foamed plastics.

9.32.2 Read about applications of foamed plastics.

9.33 Use hot gas welding to fuse plastics together.

9.34.1 Use solvents and adhesives to join plastics together.

9.34.2 Use adhesives to join plastics to non-plastics.

9.35.1 Join plastics and non-plastics with screws.

9.35.2 Join plastics and non-plastics with other fasteners.

9.36.1 Tap holes and cut threads in plastics.

Resources/Media

P-23, P-31, P-32, P-24, P-26, P-27, P-28, P-29, P-30, P-31, F-44, F-45

Equipment

aluminum molds, flexible molds, chemical goggles, chemical protective gloves and apron, portable electric drill, stirring rods, balance, hot gas welder, tap and die sets, c-clamps, screwdrivers, wrenches, rivet sets, Ball peen hammer, drill index and drills, refrigerator

Supplies

graduated paper cups, stirring sticks, resins (e.g., polyester, water extended polyester, and epoxy), mold release, foaming resins such as polyurethane, dyes, eye droppers, plastic self-tapping screws, plastic filler rod, solvents, soap or other lubricant

9. CONTENT/CONCEPT **PLASTICS - SEPARATING**

Task: 9.40 Use separating techniques on plastics.
Criterion Reference Measure: Separate plastics with scribe and snap, sawing, heating, drilling, turning, shearing, and routing.

Topics: 9.41 Scribe and Snap
9.42 Machining
9.43 Thermal Separation

Teacher's Guide:

9.40.1 Discuss commonalities in plastic separating procedures.

9.40.2 Assign reading in P-23.

9.40.3 Emphasize safety precautions in machining plastics.

9.41 Demonstrate scribe and snap method for plastics and glass.

9.42.1 Demonstrate drilling.

9.42.2 Demonstrate use of lathe.

9.42.3 Demonstrate sanding.

9.42.4 Demonstrate sawing with coping, circular, scroll, and band saw.

9.43.1 Assign reading on use of hot wire to cut plastics.

9.43.2 Demonstrate hot wire cutting of foamed plastics.

Student's Performance Guide:

9.40.1 Read about separating processes.

9.40.2 Observe the special safety precautions in machining plastics.

9.40.3 Use separating techniques in making projects.

9.41.1 Cut plastic sheet with the scribe and snap method.

9.41.2 Observe the similarities in cutting glass and plastics and discuss these similarities.

9.42.1 Determine the need for cutting fluids or compounds when machining plastics.

9.42.2 Recognize the difference in machining nature of plastics and other materials and select proper cutting tools for plastics.

9.42.3 Cut plastics with hand and power saws.

9.42.4 Drill holes in plastics.

9.42.5 Use a lathe to shape plastic stock.

9.42.6 Sand plastics by hand and with machines.

9.43 Cut foamed plastics with a hot wire cutter.

9.44 Engrave initials and designs in plastic.

Resources/Media

P-23

Equipment

coping saw, screw cutting lathe, disc and belt sander, saw (circular, scroll, coping, and band), drill press, plastic scriber, hot wire cutter, metal ruler, carbide tip circular saw blades, glass cutter, metal straight-edge, engraving pantograph, hand held electric engraving and modeling tool set

Supplies

plastic stock (sheet and rod), acrylics, polycarbonate, wet sanding discs and belts (self-adhesive), sheet glass, soap or cutting fluid

9. CONTENT/CONCEPT **PLASTICS - FORMING**

Task: 9.50 Use forming techniques on plastics.
Criterion Reference Measure: Form parts through molding and thermal processes.

Topics: 9.51 Injection Molding
9.52 Thermal Forming
9.53 Plastisol

Teacher's Guide:

9.50.1 Assign reading on forming plastics in P-23.

9.50.2 Discuss commercial molding such as transfer, compression, and extrusion.

9.51 Discuss how the type of plastic (thermoset or thermoplastic) affects the forming processes.

9.51.1 Demonstrate injection molding techniques.

9.52.1 Demonstrate compression molding, extrusion, pultrusion, and vacuum molding.

9.52.2 Demonstrate strip heating.

9.52.3 Provide activities involving expanding plastic beads.

9.52.4 Demonstrate heating and free forming plastic sheets.

9,53 Provide activities involving dip and slush molding of plastisol.

Student's Performance Guide:

9.50.1 Read about forming techniques for plastics.

9.50.2 Observe safety precautions.

9.50.3 View films on plastic processing.

9.50.4 Discuss thermal forming of plastics.

9.50.5 Use forming to make projects.

9.51 Make parts through injection molding.

9.52.1 Heat plastic pieces on strip heater and form.

9.52.2 Use vacuum molder to shape plastic parts.

9.52.3 Produce parts by expansion forming of polystryene beads.

9.53.1 Use female molds for slush molding plastisol.

9.53.2 Mold plastisol parts with rotary slush molding.

9.53.4 Apply protective plastisol coatings through dip molding.

Resources/Media

P-23, P-31, P-32, P-24, P-26, P-27, P-28, P-29, P-30, P-31

Equipment

electric range, injector molder, strip heater, high temperature oven, high temperature thermometer, compression molding press, blow molding machine, aluminum dip and slush molds, rotary molder, vacuum molder, pressure cooker, large pot, materials processing center (L-4), heat gun, hot plate, thermoformer

Supplies

snap-off cutting knife and replacement blades, injection molding pellets, acrylic sheet, plastisol resin, plastisol primer, expandable polystyrene beads

9. CONTENT/CONCEPT **PLASTICS - CONDITIONING**

Task: 9.60 Produce finished surfaces on plastics.
Criterion Reference Measure: Finish plastics with sanding, buffing, flame, and solvent methods.

Topics: 9.61 Abrasive Finishing
9.62 Flame Polishing
9.63 Solvent Finishing

Teacher's Guide:

9.60 Assign reading on plastic finishing and discuss reasons for different techniques.

9.61 Demonstrate sanding and buffing techniques.

9.62 Demonstrate flame polishing.

9.63 Demonstrate solvent polishing.

Student's Performance Guide:

9.60.1 Read about techniques for finishing plastics.

9.60.2 Observe safety precautions in finishing plastics.

9.61.1 Select proper abrasive papers, buffing compounds, and wheels to finish plastic.

9.61.2 Use sanding and buffing methods to finish plastic surfaces.

9.62 Flame polish edges of plastic sheet.

9.63 Solvent polish surfaces on plastics.

Resources/Media

P-23, P-31, P-32, P-24, P-26, P-27, P-28, P-29, P-30

Equipment

buffer and buffing wheel

Supplies

solvents, buffing compounds

10. CONTENT/CONCEPT **METALS - NATURE AND PROPERTIES**

Tasks: 10.10 Recall the basic structure of metals.
Criterion Reference Measure: Define metals and alloys and describe their behavior in terms of atomic and crystalline structure.

10.20 Recall some typical properties of metals and alloys.
Criterion Reference Measure: Explain three ways of altering the properties of metals.

Topics: 10.1 Nature of Metals
10.2 Properties of Metals

Teacher's Guide:

10.10.1 Assign reading in G-4 (Step M-1).

10.10.2 Test on objectives in G-4.

10.10.3 Demonstrate allotropic change (N-1, Experiment 11-A, p. 56).

10.10.4 Assign students to Skylab Experiments (E-19).

10.10.5 Show film on metals F-31, F-33, F-34, F-35.

10.10.6 Assign M-6 for reading on types of metals and basic processing techniques.

10.10.7 Show film on recycling, F-49.

10.20.1 Assign teams to test properties of metals for tensile strength, hardness, shear strength, and flexural strength.

10.20.2 Discuss relevance of understanding properties of metals for wise material selection and product design.

NOTE: Refer back to Topics 1.0, 2.0, and 3.0 to integrate here.

Student's Performance Guide:

10.10.1 Sketch examples of elastic and plastic deformation in metal parts.

10.10.2 List four types of defects in microstructure of metals.

10.10.3 Sketch the formation of grains as metals solidify.

10.10.4 Bend metal wire to work, harden it and break it.

10.20.1 Conduct tests of cold-worked, hot-worked, and hardened steel to compare properties.

10.20.2 Conduct tests of various alloys to compare their properties.

10.20.3 List reasons and cite examples of where a knowledge of the properties of metals is important in design of products and selection of materials.

Resources/Media

G-4, M-3, M-4, M-5, PR-1, M-6, F-45, F-31, F-33, F-34, F-35

Equipment

mechanics of materials learning system (L-3) or Universal testing machine, materials processing center (L-4), 16 mm projector, metallograph and metallurgical preparation equipment (see unit 5)

Supplies

See specimens listed for 7.31
See N-1 (p. 56)
See list on E-19

10. CONTENT/CONCEPT **METALS - FORMING**

Task: 10.30 List and demonstrate basic techniques for metal forming.
Criterion Reference Measure: Form metal parts using casting, hot forming, powder metallurgy, or sheet forming.

Topics: 10.31 Casting
10.32 Hot and Cold Forming
10.33 Powder Metallurgy
10.34 Sheet Forming

Teacher's Guide:

10.30.1 Assign reading in M-6 on metal forming methods.

10.30.2 See M-6 and M-7 for projects.

10.30.3 Discuss such casting processes as green sand, shell mold, die casting, investment casting and permanent mold.

10.31.1 Show film on casting F-32.

10.31.2 Demonstrate casting methods including sand, permanent mold and investment.

10.32.1 Show film on hot forming F-38, F-46, F-48.

10.32.2 Demonstrate and assign activities on forging, hot rolling extrusion, and other hot forming processes.

10.33.1 Show film on powder metal F-47.

10.33.2 Assign reading on powder metallurgy E-21 and E-22.

10.34 Demonstrate sheet metal forming methods.

NOTE: Each student probably will not engage in each type of metal processing. Each student should gain exposure to the various tools, equipment and processing techniques through reading, discussion and observation of demonstrations where practical.

Student's Performance Guide:

10.30.1 Read about industrial methods of forming metals.

10.30.2 View films on methods of forming metals.

10.30.3 Study safety procedures.

10.31.1 Produce parts through sand mold casting.

10.31.2 Produce parts through investment and permanent mold casting.

10.31.3 Study industrial methods of casting.

10.32.1 Produce parts by extrusion, forging, and hot rolling.

10.32.2 Study industrial methods of hot and cold forming.

10.32.3 Bend bond steel with rotary bending machine.

10.33.1 Blend metal powders.

10.33.2 Press metal powder into shape and sinter.

10.33.3 Answer test questions on advantages and disadvantages of powder metallurgy.

10.34.1 Use slip rolls and box and pan brakes to form sheet metal.

10.34.2 Study industrial forming of sheet metal such as press forming, explosive and high impact, and stretch forming.

Resources/Media

M-5, F-32, F-38, M-6, M-7, G-1

Equipment

Materials Processing Center (L-4), centrifugal caster, graphite crucibles, tongs and pouring handles, patterns, ingot molds, foundry bench, molders tools, foundry protective clothing, foundry flashes, sand riddle, shovel, anvil, box and pan brake, slip roll former, rotary bending machine, machinist vise, ball peen hammers, layout tools

Supplies

foundry sand, parting powder, aluminum ingot, band steel, CRS and HRS rod, sheet steel, aluminum, and brass, patterns

10. CONTENT/CONCEPT **METALS - SEPARATING**

Task: 10.40 Exhibit skills in basic metals separation processes. Criterion Reference Measure: Separate metals using sawing, machine drilling, grinding, and oxyacetylene cutting.

Topics: 10.40 Separating
10.41 Sawing
10.42 Machining
10.43 Drilling, Punching, and Shearing
10.44 Grinding and Filing
10.45 Oxyacetylene Cutting

Teacher's Guide:

10.40.1 Assign reading in M-5 and discuss metals separating methods for the lab and in industry.

10.40.2 See M-6 and M-7 for projects.

10.40.3 Show film on metalworking aluminum F-50.

10.41 Demonstrate safe and proper procedures for hand and machine sawing.

10.42.1 Discuss industrial machining operations including turning, spinning, milling, shaping, numerical controlled and computer controlled machining, broaching, planing, and chipless machining.

10.42.2 Demonstrate the safe and proper use of the lathe and milling machine.

10.42.3 Demonstrate thread cutting by lathe.

10.43.1 Discuss industrial processes for producing holes including drilling, punching, lasers, ultrasonics, electrical discharge machining, and press and hand punching.

10.43.2 Demonstrate drilling by hand and with drill press.

10.43.3 Demonstrate the use of taps and dies.

10.43.4 Demonstrate shearing.

10.44 Demonstrate the use of the grinder and wire brush and files.

10.45 Demonstrate the use of the oxyacetylene cutting torch.

Student's Performance Guide:

10.40.1 Study for the test and answer test questions about laboratory methods and industrial methods of metal separation.

10.40.2 Be aware of new technologies developing in metals separation.

10.41.1 Use hack saws properly.

10.41.2 Use band saws to cut metal.

10.42.1 Operate a bench lathe.

10.42.2 Operate a milling machine.

10.42.3 Cut threads on a lathe.

10.42.4 Read about and answer test questions on industrial machining processes.

10.43.1 Differentiate between S.I. metric, decimal, fractional, letter, and number systems for sizing drills.

10.43.2 Use hand and machine drills safely and properly.

10.43.3 Use hand punches and recall industrial punching processes.

10.43.4 Select appropriate drills and use taps and dies to produce threads.

10.43.5 Shear metal with hand shears and sheet metal shears.

10.44.1 Use an oil stone for sharpening.

10.44.2 Use a power grinder to shape parts.

10.44.3 Use a grinder to sharpen drills.

10.44.4 Study industrial grinding and finishing techniques such as lapping, honing, and superfinishing.

10.44.5 Select and use files on metal.

10.45.1 Use the oxyacetylene cutting torch to separate steel.

10.45.2 Study industrial processes for oxyacetylene cutting such as automated electric eye and numerically controlled cutting torches.

Resources/Media

M-5, M-6, M-7, F-50, M-8, M-9, M-10, M-11, G-1, G-11

Equipment

hand hack saws, powered hack saws, band saws, screw cutting engine lathe with complete accessories, milling machine with complete accessories, machinist vice, pedestal grinder and wire brush, files, file card, oxyacetylene outfit with cutting torch, welders protective clothing, metal punch set, drill index and drills (S.I. metric, fractional, number, and letter sizes), center punch, prick punch, tape and die sets (include pipe dies), portable electric drill, sheet metal shears, hand shears

Supplies

hack saw blades, band saw blades, oxygen tanks, acetylene tanks, grinding wheels, wire brushes, wire brush wheels, sheet steel, sheet aluminum, sheet brass, steel band and rod, aluminum band and rod

10. CONTENT/CONCEPT **METALS - COMBINING**

Task: 10.50 Exhibit skills in basic combining techniques. Criterion Reference Measure: Use welding, brazing, soldering, adhesives, and fasteners to combine metals to metals or metals to nonmetals.

Topics: 10.50 Combining
10.51 Welding
10.52 Brazing
10.53 Soldering
10.54 Adhesives
10.55 Fasteners

Teacher's Guide:

10.50.1 Assign reading in M-5 and discuss general combining processes.

10.50.2 Show films on welding F-52, F-53.

10.50.3 Call students' attention to new developments in combining such as laser and diffusion bonding.

10.50.4 Discuss selection criteria for choice of combining methods.

10.50.5 Emphasize safe procedures in the use of combining equipment.

10.51.1 Demonstrate welding with oxyacetylene and electric arc.

10.51.2 Demonstrate inert gas welding.

10.52.1 Demonstrate brazing.

10.52.2 Discuss industrial brazing techniques such as furnace brazing.

10.53.1 Demonstrate soldering methods.

10.53.2 Discuss industrial soldering methods such as float soldering.

10.54.1 Discuss the types of adhesives and adhesive bonding.

10.54.2 Demonstrate the selection and use of adhesives with metals and with metals to nonmetals.

10.55.1 Discuss the wide variety of fasteners used in industry and for everyday application.

10.55.2 Demonstrate riveting and use of threaded fasteners.

Student's Performance Guide:

10.50.1 Study assigned reading on combining methods and answer test questions.

10.50.2 Observe various methods of combining used on products.

10.50.3 Recall reasons for selecting one method of combining over another.

10.51.1 Recall safety techniques in the use of oxyacetylene welding and brazing.

10.51.2 Set up the torch and adjust the regulators for oxyacetylene welding and brazing.

10.51.3 Join metal with oxyacetylene welding using correct filler metal.

10.51.4 Use safe and correct procedures to set up electric arc equipment.

10.51.5 Select appropriate protective clothing and filler metal for arc welding.

10.51.6 Join metal with electric arc welding.

10.51.7 Recall the nature, advantages, and applications of inert gas welding.

10.52 Select appropriate filler rod and flux then braze metal together.

10.53.1 Determine which metals are suitable for soft soldering.

10.53.1 Select appropriate solder and flux and solder metals.

10.54.1 Study charts and reference material to determine suitability of adhesives for specific combining applications.

10.54.2 Join parts with adhesives.

10.54.3 Observe safety with adhesives.

10.56.1 Observe the wide variety of mechanical fasteners used on products.

10.56.2 Select appropriate fasteners for a specific combining job.

10.56.3 Apply rivets to join parts together.

10.56.4 Use threaded fasteners to join parts together.

Resources/Media

M-5, F-52, F-53, M-10, G-1, G-11

Equipment

oxyacetylene hose, torch, tank regulator, and complete accessories, complete electric arc welding set-up, electric soldering gun, soldering furnace, soldering coppers, drill presses, drill index and drill sets (S. I. metric, fractional, number and letter), portable electric drill, prick and center punch, tap and die sets, screwdrivers (Standard and Phillips), ball peen hammer, countersink, rivet sets, fastener storage, adhesive storage, chipping hammer and wire brush, 16 mm projector

Supplies

oxygen and acetylene tanks; steel welding rod; brazing rod and flux, acid, rosin, and solid core solder; assorted filler rods; assorted fasteners, assorted adhesives

10. CONTENT/CONCEPT **METALS - CONDITIONING**

Task: 10.60 Recall methods for conditioning metals.
Criterion Reference Measure: Change the structure of metals through hardening and tempering; apply protective coatings to metal.

Topics: 10.60 Conditioning
10.61 Thermal Processing
10.62 Protective Coating

Teacher's Guide:

10.60.1 Assign G-4 (Step M-2) and test over the objectives.

10.60.2 Discuss industrial methods of conditioning metals.

10.61.1 Show film from F-46 ("Heat Treatment of Aluminum").

10.61.2 Demonstrate hardening methods.

10.61.3 Demonstrate tempering methods.

10.61.4 Demonstrate case hardening.

10.62.1 Assign reading or discuss material covered in PR-7.

10.62.2 Demonstrate applications of protective coatings.

10.62.3 Discuss annodizing and plating.

Student's Performance Guide:

10.60.1 Study the assigned reading on thermal processing of metals and answer test questions based on the objectives in G-4.

10.60.2 Interpret an iron-carbide equilibrium diagram.

10.60.3 Discuss industrial methods of conditioning metals.

10.60.4 Experiment with allotropic change.

10.61.1 Heat and quench steel to produce a desired hardness.

10.61.2 Test steel specimens to determine the effects of thermal processing on hardness and toughness.

10.61.3 Draw the temper on a hardened steel part.

10.61.4 Case harden a steel part.

10.62.1 Study methods used in the lab and industry to provide protective coatings to metals.

10.62.2 Apply protective coatings to metal parts.

Resources/Media

G-4, S-3, "Heat Treatment of Aluminum" (F-46), PR-7, G-1, G-11

Equipment

Brinell hardness attachment, heat treating furnace and pyrometer, quench tank, bunsen burner, oxyacetylene welding outfit, paint brushes, oily rag storage can, 16 mm projector

Supplies

oil, case hardening compound, assorted paints and primers, spray paint, solvents, paint thinner, rags

11. CONTENT/CONCEPT **WOODS - NATURE AND PROPERTIES**

Tasks:

11.10 Analyze the basic nature of woods and forest products.
Criterion Reference Measure: Explain the biological origin of forest products, and describe the structure of wood and paper.

11.20 Recall typical properties of woods.
Criterion Reference Measure: Test woods to determine physical, mechanical, chemical, and biological properties of specific wood specimens.

Topics:

11.1 Nature of Forest Products
11.2 Properties of Wood

Teacher's Guide:

11.10.1 Assign reading in G-4 (Step A-1) and test over objectives.

11.10.2 Discuss the forest products industry, ecology, and conservation.

11.10.3 Tell the story of the tree from its biological origins, through harvesting, and production of forest products.

11.10.4 Take field trips to forest products manufacturers.

11.10.5 Discuss wood as a natural replenishable resource that can serve as a fuel.

11.11.1 Show examples of wood grain, various cuts of lumber, and types of defects typical in lumber.

11.11.2 Discuss the wide variety of forest products such as paper, alcohol, and wood composites.

11.11.3 Discuss methods of purchasing forest products.

11.11.4 Assign teams to experiment E-15.

11.20.1 Assign reading in P-17.

11.20.2 Discuss techniques used to season lumber.

11.20.3 Discuss grading of lumber.

11.21.1 Discuss general properties of wood covered in G-4 (Step A-1).

11.21.2 Discuss methods of destructive and non-destructive testing of wood.

11.22.1 Discuss physical properties of wood.

11.22.2 Assign students to experiment on wood specimens N-7, G-4(5).

11.23.1 Discuss mechanical properties of wood.

11.23.2 Assign teams to determine mechanical properties from G-4, E-16, and E-17.

11.24.1 Discuss chemical and biological properties of woods.

NOTE: Refer back to Topics 1.0, 2.0, and 3.0 to integrate here.

Student's Performance Guide:

11.10.1 Study books dealing with trees, forestry, harvesting and production of the many products of the forest.

11.10.2 Read about the nature of wood and take tests on the objectives.

11.10.3 Study about forestry and the forest products industry.

11.10.4 Observe the variety of forest products used in our society.

11.10.5 Study about wood as a fuel and determine which woods are the most practical fuels.

11.10.6 Discuss wood as a replenishable resource.

11.11.1 Examine wood specimens for grain differences, colors, textures, and odors.

11.11.2 Locate defects in lumber and discuss their cause and their effects on properties.

11.11.3 Calculate the cost of lumber by board foot measure.

11.11.4 Select specific types of wood for a given application.

11.12 Construct models of softwood and hardwood structures.

11.20.1 Read about methods of seasoning wood.

11.20.2 Read about grading of lumber.

11.21.1 Use the Woods Handbook (P-11) to determine general properties of specific wood species.

11.21.2 Read about destructive and non-destructive testing of wood.

11.22.2 Conduct tests of specific gravity of various wood specimens.

11.23.1 Test the hardness of wood specimens (E-16).

11.23.2 Test the flexural strength of various wood specimens (E-17).

11.23.3 Test the impact strength of woods.

11.23.4 Experiment on chemical resistance of woods compared to other materials.

11.23.5 Read about biological properties of woods.

11.23.6 Note locations and types of wood that have been biologically attacked by insects, vegetation, and rot.

Resources/Media

G-4, P-17, P-5, P-12, P-6, P-9, P-13, N-7, P-11, P-18

Equipment

high temperature oven, high temperature thermometer (^{o}F and ^{o}C), balance, universal testing machine or materials processing center, graduate cylinder

Supplies

wood specimens and/or lumber: pines, spruce, fir, cedar, mahoganies, walnut, bass wood, maple, oaks, birch, redwood, beech, cypress, poplar, and ash

11. CONTENT/CONCEPT **WOODS - SEPARATING**

Task: 11.30 Use separating techniques on woods.
Criterion Reference Measure: Separate wood by hand and machine using sawing, planing, jointing, chiseling, scraping, filing, turning, drilling, mortising, and sanding.

Topics: 11.30 Separating
11.31 Sawing
11.32 Planing/Jointing
11.33 Chiseling/Scraping/Filing
11.34 Turning
11.35 Drilling/Mortising/Routing
11.36 Sanding

Teacher's Guide:

11.30.1 Assign reading in P-17 on separation techniques.

11.30.2 Locate projects in P-17, P-18.

11.30.3 Discuss and demonstrate proper and safe procedures with woodworking tools and equipment.

11.30.4 Provide activities for students to develop skills on hand and machine tools.

11.31.1 Discuss types of hand saws and demonstrate.

11.31.2 Explain selection of saws and saw blades.

11.32 Discuss the selection, care, and use of hand planes, planers, and jointers.

11.33.1 Demonstrate how to sharpen plane blades (iron) and how to adjust planes.

11.33.2 Discuss the selection and use of chisels, scrapers, and files.

11.34.1 Discuss the types of turning possible on a wood lathe.

11.34.2 Demonstrate the set-up of face plate and between center wood turning.

11.35.1 Discuss types and uses of hand and machine drills.

11.35.2 Demonstrate drill sharpening.

11.35.3 Discuss and demonstrate mortising and routing.

11.36.1 Discuss the types of abrasive papers and clothes used on wood.

11.36.2 Demonstrate sanding techniques.

NOTE: It is doubtful that each student will be able to engage in each type of processing of woods. All students should be made aware of the various tools, equipment, and techniques by reading, discussing, and observing demonstrations where practical.

Student's Performance Guide:

11.30 Study proper and safe operation of hand and machine woodworking tools.

11.31.1 Saw wood with hand saws.

11.31.2 Saw wood with portable electric saws.

11.31.3 Saw wood on table, band, radial arm, and jigsaws.

11.32.1 Select, adjust, and properly use hand planes.

11.32.2 Sharpen plane blades (iron) on an oil stone.

11.32.3 Machine wood on planers and jointer.

11.33.1 Use a chisel on wood.

11.33.2 Shape wood with a spoke shave.

11.33.3 Select and use files, rasps, and surf planes.

11.33.4 Dress cross-grained and irregular wood surfaces with scrapers.

11.34.1 Set up wood pieces for face plate turning.

11.34.2 Set up wood pieces for turning betweeen centers.

11.34.3 Select proper tools and produce wood turnings on a lathe.

11.35.1 Sharpen twist drills.

11.35.2 Select proper drills or hole saws to produce holes in wood.

11.35.3 Shape edges and inside cuts with a router.

11.36.1 Select appropriate abrasive paper for a given finishing job.

11.36.2 Sand wood by hand and with machine sanders.

Resources/Media

P-17, P-18, P-16

Equipment

table saw, radial arm saw, portable circular saw, portable scroll saw, band saw, extension cords, coping saw, compass saw, miter box and saw, cross-cut saw, back saw, smoothing plane, block plane, spokeshave, oil stone, grinder, oil can, bench vise, vise dog, hand scrapers, round wood files, half round wood files, wood rasps, surf planes, file cards, drill sets, drill indexes, hand drill, drill press, portable electric drills, wood lathes, routers, dado heads, dividers, calipers, wooden mallets, turning tools, face plates, hole saws, plug cutter, drum rasp, router bits, mortising chisel, wood chisels, gouges, portable belt sander, combination belt and disc sander, mortising attachment, mortising drills, try squares, marking gauges

Supplies

circular saw blades (combination, carbide tip, and plywood), band saw blades, scroll saw blades various species of lumber, grinding wheels, oil, router heads and blades, twist drills, sanding belts, assorted abrasive papers and cloth (sheet, belt, and disc), abrasive paper adhesive

11. CONTENT/CONCEPT **WOODS - COMBINING**

Task: 11.40 Select a method and combine wood.
Criterion Reference Measure: Join wood with adhesives and mechanical fasteners.

Topics: 11.40 Combining
11.41 Adhesive Joining
11.42 Mechanical Fastening

Teacher's Guide:

11.40.1 Assign reading in P-17 on combining wood.

11.40.2 Discuss industrial methods for combining wood.

11.40.3 Explain selection criteria to determine most appropriate combining technique.

11.41.1 Discuss various wood adhesives, their properties, advantages, disadvantages, and methods of use.

11.41.2 Demonstrate wood lamination.

11.41.3 Discuss wood joints.

11.41.4 Assign groups to experiment with adhesives and joints (E-18).

11.42.1 Discuss the various mechanical fasteners used on wood and how they are sized.

11.42.2 Demonstrate techniques for joining wood with mechanical fasteners.

Student's Performance Guide:

11.40.1 Read about methods of combining wooden parts.

11.40.2 Observe wooden products to determine the types of joints and means of holding the parts together.

11.40.3 Test wood joints to determine their best application (E-18).

11.41.1 Study the variety of adhesives used on wood.

11.41.2 Select wood adhesives for a given application.

11.41.3 Choose the proper joint, cut the wood parts, and join the parts with the appropriate adhesive.

11.42.1 Study and take notes on the wide variety of adhesives used on products and buildings.

11.42.2 Answer test questions on the systems for sizing nails, wood screws, brads, and other wood fasteners.

11.42.3 Prepare wood joints for mechanical fasteners.

11.42.4 Combine wooden parts with mechanical fasteners.

Resources/Media

P-17, E-18, PR-4, P-20

Equipment

universal testing machine or materials processing center, drill press, twist drills, bar clamps, screw clamps, C-clamps, electric hot glue gun, screw drivers (Standard and Phillips), adjustable jaw, box end, and open end wrenches, claw hammer, nail sets, and pilot drills

Supplies

assortment of nails, screws, brads, hinges, latches, handles, glue gun sticks, various glues such as polyvinyl resins, casins, contact cement, epoxy, and resorcinal, various softwood and hardwood lumber

11. CONTENT/CONCEPT **WOODS - FORMING**

Task: 11.50 Recall methods of forming wood.
Criterion Reference Measure: Form wood through steaming and laminating.

Topic: 11.5 Forming

Teacher's Guide:

11.50 Assign reading on methods of forming wood in P-17.

11.51 Discuss industrial methods and applications of steam formed and laminated woods.

11.52 Demonstrate methods of forming wood.

Student's Performance Guide:

11.50 Study industrial and laboratory techniques and uses for formed wood.

11.51 Construct wood-forming jigs and dies.

11.52 Use laminating techniques tc form wooden parts.

11.53 Use steaming techniques to form wooden parts.

Resources/Media
P-17

Equipment
C-clamps, bar clamps, screw clamps, laminating machine, large steaming drum, electric range

Supplies
wood veneer, assorted lumber

11. CONTENT/CONCEPT **WOODS - CONDITIONING**

Task: 11.60 Determine appropriate conditioning to ensure wood preservation.
Criterion Reference Measure: For a given service condition select such conditioning as seasoning, penetration finishes, transparent coatings, or paint.

Topics: 11.60 Conditioning
11.61 Seasoning and Preserving
11.62 Preparation for Finishing and Coatings
11.63 Penetrating Finishes
11.64 Transparent Coatings
11.65 Paint

Teacher's Guide:

11.60.1 Assign reading on seasoning, preserving, and finishing wood in P-17.

11.60.2 Discuss the reason for wood conditioning.

11.60.3 Discuss safe and proper methods of using solvents and finishes.

11.61.1 Explain conditioning techniques such as kiln drying, salt treating, and creosote impregnation.

11.61.2 Discuss situations requiring various seasoning and preservative methods.

11.62.1 Discuss and demonstrate finish sanding, fillers, stains, dent removal, and sealing.

11.62.2 Discuss selection of solvents and solvent safety.

11.63.1 Discuss the use and care of paint brushes and other finishing tools.

11.63.2 Discuss and demonstrate penetrating finishes.

11.64 Discuss and demonstrate transparent finishes.

11.65 Discuss and demonstrate paint and painting.

11.66 Discuss wood burning.

Student's Performance Guide:

11.60.1 Read about reasons for and methods used to season, preserve, and finish wood.

11.60.2 Conduct tests of various finishes to determine which are best for specific applications.

11.60.3 Study precautions necessary in safely handling solvents and protective finishes.

11.61 Determine which seasoning and treatment best fit certain service conditions of various woods.

11.62.1 Use abrasives and scrapers to prepare wood for finishing.

11.62.2 Apply fillers, stains, and sealers to wood.

11.62.3 Properly use brushes, rollers, and other finishing tools.

11.62.4 Select appropriate solvents to thin finishes and clean finishing tools.

11.63 Select and apply appropriate penetrating finishes to woods.

11.64 Select and apply appropriate transparent coatings to wood.

11.65 Select and apply appropriate paint to wood.

Resources/Media

P-17, PR-7, PR-9, P-7, P-8, PR-10

Equipment

paint brushes and rollers, oily rag storage cans, soldering irons, volatile and flammable liquid storage containers, sink with hot and cold water, hand scrapers, aerosol spray applicators.

Supplies

canned spray paint, rags, solvents and thinners (naphtha, turpentine, lacquer thinner, denatured alcohol), oil stain, water stain, paste wood filler, shellac, lacquer, varnish, enamel, latex paint, oil paint, abrasive paper and cloth, steel wool, pumice, shellac sticks, paste wax, linseed oil, rottenstone, rubbing oil, Japan drier, plastic wood filler, putty, aerosol spray cans

12. CONTENT/CONCEPT **CERAMICS - NATURE AND PROPERTIES**

Tasks: 12.10 Recall the basic structure of ceramics.
Criterion Reference Measure: Diagram a single chain of silicate and name at least four groups of ceramics.

12.20 Recall some typical properties of common ceramics.
Criterion Reference Measure: List three ceramics and specify their applications which reflect their unique properties.

Topics: 12.1 Nature of Ceramics
12.2 Properties of Ceramics

Teachers' Guide:

12.10.1 Assign reading in G-4 (Step A-1).

12.10.2 Test on objectives in G-4.

12.10.3 Discuss history of pottery and ceramics.

12.11.1 Demonstrate glass cutting and discuss amorphous and crystalline structure.

12.11.2 Discuss sources of raw materials used for various groups of ceramics.

12.11.3 Discuss various pottery materials such as kaolin clay, glazes, and slip.

12.20 Discuss the unique mechanical, optical, and thermal properties of ceramics.

12.21.1 Allow students to develop lists of limiting properties of ceramics.

12.21.2 Discuss electrical/electronic properties of ceramics and their applications in products.

12.21.3 Assign teams to test the tensile strength of optical and other glass fibers and to compare their strength to metal wire and polymeric fibers.

12.21.4 Assign teams to test reinforced concrete vs. non-reinforced concrete.

NOTE: Refer back to Topics 1.0, 2.0, 3.0 to integrate here.

Student's Performance Guide:

12.10.1 Study about ceramic materials and pass a test on the nature and structure of ceramics.

12.10.2 Determine why glass may be a very important future material and possibly replace much of the plastics used currently.

12.10.3 Observe pottery and ceramics in museums, industry home, and other common places.

12.11.1 Draw the unit tetrahedral and chain polymer of silica.

12.11.2 Locate common and unique applications of ceramics and discuss.

12.11.3 Explain how glass differs from most other ceramics.

12.11.4 Explain the origin and development of ceramic materials on earth.

12.11.5 Write a research paper on ceramic raw materials.

12.20.1 Analyze specific ceramics and explain how their structure and properties account for a given application.

12.20.2 Explain sizing used on such ceramics as abrasive grit.

12.21.1 Conduct test to measure mechanical, optical, and thermal properties and other physical and chemical properties of ceramics.

12.21.2 Determine why silica tiles were selected for use on NASA's Space Shuttle and explain the problems associated with the tiles.

12.21.3 Select ceramics for use on projects to show an awareness of their favorable properties.

12.21.4 Select abrasive papers, stones, or wheels based on the property of the ceramic grit and its intended application.

Resources/Media

C-4, C-3, C-10, C-11

Equipment

glass cutter, mechanics of materials learning system or universal testing machine

Supplies

assorted glass samples; assorted rocks, gems, pottery, whiteware, etc; glass fibers, optical glass fibers

12. CONTENT/CONCEPT **CERAMICS - PROCESSING**

Task: 12.30 Produce ceramic products.
Criterion Reference Measure: Combine raw materials of such ceramics as cement, plaster of Paris, or pottery and process them into a finished part.

Topics: 12.30 Processing
12.31 Combining
12.32 Forming
12.33 Conditioning
12.34 Separating

Teacher's Guide:

12.30.1 Assign reading in C-4 on methods of processing ceramics.

12.30.2 Discuss commercial practices for items or materials such as concrete, porcelain, glass, gem stones, abrasive wheels and papers, and gypsum dry wallboard.

12.30.3 Refer to references for projects and activities related to processing ceramics.

12.31.1 Demonstrate mixing cement, plaster of Paris, grout, and slip slurry.

12.31.2 Explain the function of glaze and demonstrate its application.

12.32.1 Arrange field trips to allow students to observe commercial methods of forming ceramics.

12.32.2 Discuss and demonstrate ceramic forming techniques.

12.33.1 Demonstrate the techniques for drying and firing pottery.

12.33.2 Discuss precautions in ridding greenware of vapor pockets before firing.

12.33.3 Discuss curing stages necessary for concrete.

12.33.4 Assign teams to construct molds and fabricate concrete parts (reinforced and non-reinforced).

12.34.1 Discuss industrial methods of separating ceramics such as scribe and snap, laser, and ultrasonics.

NOTE: Each student probably will not engage in each type of ceramic processing. Each student should gain exposure to the various tools, equipment, and processing techniques through reading, discussing, and observing demonstrations where practical.

Student's Performance Guide:

12.30.1 Study commercial methods of processing ceramics and study ceramics parts/products to determine the probable method used in their production.

12.30.2 Read about glass making.

12.30.3 Take field trips to observe processing of ceramics such as concrete, brick, block, glass, and pottery.

12.30.4 Become familiar with terms such as refractory, grog, brisque, slip, glaze, concrete, screening, abrasives, and extrusion.

12.31.1 Study about commercial methods of combining ceramic raw materials such as cement, plaster of Paris, glass, potters clay, glazes, and grout.

12.31.2 Combine basic ingredients to produce concrete, plaster of Paris, glazes, or slip slurry.

12.32.1 Study textbooks on techniques for forming ceramics.

12.32.2 Form ceramic parts by such methods as plastic clay forming (pinch, coil, slab, and modeling), jiggering and jolleying, and slip casting (drain and solid).

12.32.3 Create decorative textures on plastic clay parts.

12.32.4 Form stiff-plastic clay with press forming.

12.33.1 Study commercial techniques for conditioning ceramics.

12.33.2 List two methods in which the strength of glass can be increased.

12.33.3 Apply glazes to ceramic products.

12.33.4 Follow proper methods in preparing ceramics including wedging, drying, and firing.

12.33.5 Explain the effect of drying and firing on the structure of greenware.

12.33.6 Use pyrometric cones as an aid to firing greenware.

12.33.7 Study silk-screen decorating of ceramics.

12.34.1 Recognize the difficulty in separating solid glass and brisque.

12.34.2 Study commercial methods for separating ceramics.

12.34.3 Use appropriate methods to separate such ceramics as glass and brick.

Resources/Media

C-3, C-4, C-5, C-6, C-7

Equipment

clay storage box, kiln, slip casting molds, wedging board, electric jiggering machine, modeling tool set, flexible rubber molds, bat slab, slip screen

Supplies

kaolin clay, plaster of Paris, dry Portland cement mix, pyrometric cones, assorted glazes, slip

13. CONTENT/CONCEPT **COMPOSITES - NATURE AND PROPERTIES**

Task: 13.10 Recognize the value of composite materials. Criterion Reference Measure: Analyze the nature and properties of composites in relation to monolithic materials.

Topics: 13.1 Nature of Composites
13.2 Properties of Composites

Teacher's Guide:

13.10.1 Assign reading in G-4 (Step A-1).

13.10.2 Show film on fiber reinforced plastics F-56.

13.10.3 Locate articles in periodicals on new composites and new applications of composites.

13.10.4 Suggest that students locate articles on composites in Popular Science, Materials Engineering, etc.

13.11.1 Show students samples of the various types of composites such as particle board, fiber glass, plastic laminated plywood, graphite epoxy, and wood resin impregnation.

13.11.2 Assign teams to construct particle board specimens (E-22).

13.20 Use references and handbooks to locate and compare properties of composites and monolithic materials.

13.21 Conduct test to compare the strength of plastic resins of such reinforcers as glass fibers, wood shavings, cotton cloth, etc.

Student's Performance Guide:

13.10.1 Read about the nature of composite materials and take a test on the objectives.

13.10.2 View a sound/filmstrip on fiber reinforced plastics and write a review.

13.10.3 Locate articles in magazines and newspapers that discuss composites and their applications. Report on the articles in class.

13.11.1 Look for composites in products such as automobiles, sports equipment, and tools.

13.11.2 Compare cost of similar products constructed of composites to monolithic materials e.g., graphite epoxy tennis rackets to aluminum rackets, and laminated wooden rackets.

13.11.3 Collect specimens and photos of composites and prepare a display or bulletin board with them.

13.11.4 Make a particle board specimen.

13.20.1 Test samples of composite materials to compare their properties to other materials.

13.20.2 Use handbooks and references to locate and compare properties of composites and other materials.

13.20.3 Make specimens with polyester and epoxy resins reinforced with fibers and particles. Test these specimens.

Resources/Media

G-4, CO-2, CO-3, CO-4, E-21, F-56

Equipment

universal testing machine or mechanics of materials learning system

Supplies

polyester resin or water extended polyester, glass fiber cloth, wood shavings, cotton rags, acetone (solvent), epoxy, mold release, cardboard and tape (to construct molds)

13. CONTENT/CONCEPT **COMPOSITES - PROCESSING**

Task: 13.30 Produce composite parts.
Criterion Reference Measure: Use combining, forming, separating, and conditioning methods to make reinforced plastic products.

Topics: 13.30 Processing
13.31 Combining
13.32 Forming
13.33 Separating
13.34 Conditioning

Teacher's Guide:

13.30.1 Assign reading in CO-1 on procedures of fiber glass processing.

13.30.2 Select projects from CO-1.

13.30.3 Assign teams to reinforce styrofoam parts with fibers (E-23).

13.30.4 Ensure that there is ventilation.

13.30.5 Caution students in handling resins and glass fibers.

13.31 Demonstrate procedures of mixing resins and combining reinforcing materials to produce reinforced plastics.

13.32 Discuss molding and forming methods used on composites.

13.33 Instruct students on precautions, techniques, and equipment used on composites.

13.34.1 Discuss and demonstrate methods of producing patterns and textures on reinforced plastics.

13.34.2 Demonstrate the use of glass cloth and resin for body patching such as used on automobiles.

13.34.3 Discuss and demonstrate methods of finishing plywood.

NOTE: Each student probably will not gain hands-on experience for each type of process. Each student should be exposed to the various tools, equipment, and processing techniques through reading, discussing, and observing demonstrations where practical.

Student's Performance Guide:

13.30.1 Read about industrial methods of producing and processing various composites.

13.30.2 Study techniques for making products of reinforced plastics.

13.31.1 Construct molds for forming or casting reinforced plastic parts.

13.31.2 Mix resins and combine reinforcing materials.

13.31.3 Mix catalyst and resin and combine with glass cloth for body patching.

13.32 Use molds to compression form reinforced plastic parts.

13.33 Select appropriate tools, wear protective devices, and use correct techniques for separating reinforced plastics.

13.34.1 Use correct procedures in curing reinforced plastics.

13.34.2 Condition plywood and particle board for various service environments.

13.34.3 Cover end grain with veneer for improved appearance.

Resources/Media

CO-1

Equipment

electric motor buffer, band saw w/metal cutting, smooth plane, wood, file, duck decoy or similar pattern, tin snips, squeegee, rubber roller, putty knife, assorted molds, fiber glass chopper, protective clothing and goggles, plywood saw stand, portable electric saw

Supplies

buffing wheel, acrylic buffing compound, mold release, paste wax, glass fibers, polyester resin, styrene monomer, MEK peroxide catalyst, wet or dry paper (assorted grit), paint brushes, paper mixing cups, metal cutting bandsaw blade, body patch kits, plywood, glass woven roven, eye droppers, color pigments, mixing sticks, acetone, wiping rags, paper measuring cups, butcher-paper rolls, cans, disposable plastic gloves, plywood veneer edging strips, exterior varnish, contact cement

RESOURCES AND SUPPORTING MEDIA

RESOURCES AND SUPPORTING MEDIA

There seems to be no comprehensive textbook for use in materials and processes technology. Consequently, several books are recommended for the course. This view is shared by researchers including the author and such curriculum teams as those who developed the materials and processes curriculum guide for Florida. A comprehensive textbook would be quite large and expensive while reducing flexibility to localities. The recommendation for this course is to have each student use the paperback, Industrial Materials Technology (G-4)*, for basic concepts on materials. For methods of processing each group of materials and special information such as careers in that field, each class should possess a library of five to seven copies of the inexpensive basic books as well as one or two copies of specialized books chosen from the following list. Activities and readings in this guide are keyed to this recommendation. The books and curriculum guide designations follow:

Plastics: Basic Industrial Arts (P-23)*
Manufacturing Processes: Metals (M-5)*
Units in Woodworking (P-17)*
Manufacturing Processes: Ceramics (C-3)*
Fiberglass (CO-1)*

*Section designations: G - General
P - Polymers
M - Metals
C - Ceramics
CO - Composites

RESOURCES AND SUPPORTING MEDIA

GENERAL

G-1 DeGarmo, Paul E., Materials and Processes in Manufacturing, New York: The MacMillan Co., 1977.

G-2 Encyclopedia of Careers, Chicago, Illinois: J. G. Ferguson Publishing Co., 1979.

G-3 Career Opportunities for Engineering Technicians, Chicago, Illinois: J. G. Ferguson Publishing Co., 1969.

G-4 Jacobs, James A. and Thomas F. Kilduff, Industrial Materials Technology, Gatling Printing and Publishing, 3347 Enterprise Road, Norfolk, Virginia, 23502, 1980.

G-5 Groneman, Chris H. and John L. Feirer, General Industrial Education, New York: McGraw-Hill, 1974.

G-6 Lindbeck, John R., General Industry, Peoria, Illinois: Charles C. Bennett Co., 1969.

G-7 Jacobs, James A. and Thomas F. Kilduff, Introduction to Materials Technology, Worcester, Massachusetts: Davis Publications, scheduled for 1980.

G-8 Occupational Outlook Handbook, U. S. Government Printing Office, Washington, D. C., 20402, biannual editions. Available in counselor offices and public libraries.

G-9 Beakley, George C. and H. W. Leach, Careers in Engineering and Technology, New York: The MacMillan Co., 1979.

G-10 Wert, Charles, Opportunities in Materials Science and Engineering, New York: Universal Publishing and Distributing Corporation, 1973.

G-11 Kazanas, H. C., et al., Technology of Industrial Materials, Peoria, Illinois: Charles A. Bennett Co., 1974.

G-12 Earle, James H., Design Drafting, Reading, Massachusetts: Addison-Wesley, 1972.

G-13 Fales, James, Everett Sheets, Gregg Mervich and John Dinan, Manufacturing: Basic Text for Industrial Arts, Bloomington, Illinois: McKnight, 1980.

G-14 Wagner, Willis, Modern Technology, Chicago, Illinois: American Technical Society, 1975.

G-15 Beakley, George C. and H. W. Leach, Careers in Engineering Technology (2nd ed.), New York: The MacMillan Co., 1979.

G-16 DeVore, Paul, Technology: An Introduction, Worcester, Massachusetts: Davis Publications, Inc., 1980.

G-17 Bame, E. Allen, and Paul Cummings, Exploring Technology, Worcester, Massachusetts: Davis Publications, Inc., 1980.

NATURE AND PROPERTIES OF MATERIALS

N-1 Parker, E. R., et. al., Solid Static Structure and Reactions, Metals Park, Ohio, 44073, American Society for Metals, 1969. Also Teacher's Guide.

N-2 Materials: A Scientific American Book, San Francisco: W. H. Freeman and Co., 1967.

N-3 Pollack, Herman W., Materials Science and Metallurgy, Reston, Virginia: Reston Publishing, 1973.

N-4 Van Vlack, L. H., A Textbook of Materials Technology, Reading, Massachusetts: Addison-Wesley, 1973.

N-5 Clauser, Henry R., Industrial and Engineering Materials, New York: McGraw-Hill, 1975.

N-6 Subbaras, E. C., et. al., Experiments in Materials Science, New York: McGraw-Hill, 1973.

N-7 Foulger, A. N., Classroom Demonstration of Wood Properties #PA-900, Superintendent of Documents, U. S. Government Printing Office, Washington, D.C., 20402, April 1969. 60 cents.

N-8 Laboratory Experiments in the Chemistry and Physics of Steel, United States Steel Corporation, Public Relations Dept., 71 Broadway, New York, 10006. Free classroom quantities.

N-9 Corrosion in Action, International Nickel Company, One New York Plaza, New York, 10004. Free classroom quantities.

N-10 Materials Technology Laboratory Manual, Vega Enterprises, R.R. No. 4, Box 3008, Decatur, Illinois, 62526.

Free Company Periodicals:

N-11 Corning News, Corning Glass Works, Corning, New York, 14830.

N-12 Nickel Topics, International Nickel Company, One New York Plaza, New York, N.Y., 10004.

N-13 Innovation, E. I. du Pont de Nemours, Public Relations, Chestnut Run, Wilmington, Delaware, 19898.

N-14 Materials News, Dow Corning Corporation, Public Relations, Midland, Michigan, 48640.

N-15 Casteel, Steel Founder's Society of America, 20611 Center Ridge Road, Rocky River, Ohio, 44116.

Periodicals:

N-16 Popular Science, Subscription Department, Boulder, Colorado, 80302.

N-17 Materials Engineering, P.O. Box 95759, Cleveland, Ohio, 44101.

N-18 Modern Plastics, P.O. Box 430, Hightstown, New Jersey, 08520.

N-19 Plastics World, P.O. Box 5391, Denver, Colorado, 80217.

N-20 Klein, P. W. and P. Ludwig, "Falling Dart Impact Test," Industrial Education, November, 1979, pp. 58-59.

Samples:

N-21 Taconite samples and other audio-visual material. Order from: Director of Communications, Reserve Mining Co., Silver Bay, MN 55614. Free with request.

N-22 Display samples of Refined Oil; Coastal Texas Crude Oil; Sulfur; Good Gulf Gasoline (Simulated); Home Heating Oil (also Diesel Fuel); Wax Bearing Lubricating Oil Distillate; Coke; Lubricating Oil; Jet Fuel A; Gulfcrest Gasoline, Unleaded (Simulated); and Residual Fuel Oil. Order from: Director - Laboratory, Gulf Oil Company, P.O. Box 701, Port Arthur, TX 77640.

CERAMICS

C-3 Gregor, Thomas G., Manufacturing Process: Ceramics, Englewood Cliffs, New Jersey: Prentice-Hall, 1976.

C-4 Nigrosh, Leon I., Claywork: Form and Idea in Ceramic Design, Worcester, Massachusetts: Davis Publications, 1975.

C-5 Mavros, Donald, Getting Started in Ceramics, New York: Bruce Publishing, 1971.

C-6 Thorp, Harold E., Basic Pottery for Students, London: Alec Tiranti Ltd., 1969.

C-7 Nelson, Glenn C., Ceramics: A Potter's Handbook, New York: Holt, Rinehart and Winston, 1971.

C-8 Diamond, Freda, The Story of Glass!, New York: Harcourt, Brace and Company, 1953.

C-9 Design and Control of Concrete Mixtures (11th ed.), Portland Cement Association, Old Orchard Road, Skokie, Illinois, 60076. Free book.

C-10 All About Glass, Corporate Communications Division, Corning Glass Works, Corning, New York, 14830. Free book.

C-11 Properties of Glasses and Glass Ceramics, Corning Glass Works, Corning, New York, 14830. Free book.

C-12 Nelson, Glenn C., Ceramics, New York: Holt, Rinehart, and Winston, Inc., 1960.

C-13 Jones, J. T. and M. F. Berard, Ceramics Industrial Processing and Testing, Ames: Iowa State Press, 1972.

C-14 Norton, F. H., Elements of Ceramics (2nd ed.), Reading, Massachusetts: Addison-Wesley Publishing, 1974.

COMPOSITES

CO-1 Steele, G. L, Fiberglass, Bloomington, Illinois: McKnight, 1962.

CO-2 Peterson, Franklynn and Judi R. Kesselman, "New-Generation Particleboard," Popular Science, January, 1980, pp. 117-119.

CO-3 Bolon, Paul, "Finishing Plywood," Popular Science, January, 1980, pp. 114-116.

CO-4 Lindsley, E. F., "Composites - How They'll Make Cars Lighter, Stronger," Popular Science, April, 1979, pp. 89-91.

METALS

M-3 Steel in the Making, Bethlehem Steel Corporation, Public Relations, Bethlehem, Pennsylvania, 18016. Free book.

M-4 Allen, Dell K. and Kay S. Mortensen, Metallurgy and Materials Science Laboratory Manual, Chicago, Illinois: American Technical Society, 1973.

M-5 Kazanas, H. C. and Lyman Hannah, Manufacturing Processes: Metals, Englewood Cliffs, New Jersey: Prentice-Hall, 1976.

M-6 Boyd, T. G., Metalworking, South Holland, Illinois: Goodheart-Willcox, 1978.

M-7 Walker, J. R., Metal Projects, South Holland, Illinois: Goodheart-Willcox, 1966.

M-8 Krar, S. F. and J. W. Oswald, Turning Technology, Albany, New York: Delmar, 1971.

M-9 Krar, S. F. and J. W. Oswald, Drilling Technology, Albany, New York: Delmar, 1977.

M-10 Griffin, Roden, and Briggs, Welding Processes, Albany, New York: Delmar, 1978.

M-11 McCarthy, W. J. and V. E. Repp, Machine Tool Technology, Bloomington, Illinois: McKnight, 1979.

POLYMERS

P-3 Synthetic Rubber: Story of an Industry, 45 Rockefellar Plaza, New York: International Institute of Synthetic Rubber Producers, 1973. Free book.

P-4 Making Paper from Trees (FS-2), Forest Products Laboratory, U. S. Department of Agriculture, Madison, WI 53705. Free classroom quantities.

P-5 "Some Books About Wood and Related Subjects," U. S. Forest Products Laboratory. Free.

P-6 "Wood in the Energy Crisis," "The Many Forms of Wood as Fuel," "Utilization of Hardwoods for Energy," reprints, U.S. Forest Products Laboratory. Free.

P-7 "Painting and Finishing," reprint of Chapter 16, Wood Handbook, U.S. Forest Products Laboratory. Free.

P-8 "Wood Finishing: Water Repellents and Preservatives," Research Note FPL-0124, U.S. Forest Products Laboratory. Free.

P-9 "Inside Wood . . . Layman," FPL-014, U.S. Forest Products Laboratory. Free.

P-10 Machining and Related Characteristics of U. S. Hardwoods, Technical Bulletin 1267, U.S. Forest Products Laboratory. Free.

P-11 Wood Handbook (No. 72) Stock No. 0100-03200, Order from Superintendent of Documents, U. S. Government Printing Office, Washington, D.C. 20402. Price $7.85.

P-12 Wood: Colors and Kinds (No. 101), Superintendent of Documents, U. S. Printing Office. Price $0.75.

P-13 Kruppa, R. A., "Wood Materials: A Bibliography," School Shop, December 1979, pp. 14 and 15.

P-14 Coleman, D. G., "Properties, Selection and Suitability of Woods for Woodworking," U. S. Forest Products Laboratory. Free.

P-15 Adhesive Bonding of Wood, Technical Bulletin 1512, U. S. Forest Products Laboratory. Free

P-16 Feirer, John L., Woodworking for Industry, Peoria, Illinois: Charles A. Bennett, Co.

P-17 Douglass, Penny and Roberts, Units In Woodworking, Albany, New York: Delmar Publishers, Inc., 1973.

P-18 Wagner, Willis H., Woodworking, South Holland, Illinois: Goodheart-Willcox, 1975.

P-19 Wagner, Willis H., Modern Carpentry, South Holland, Illinois: Goodheart-Willcox, 1979.

P-20 Baker, G. E. and L. D. Yeager, Wood Technology, Indianapolis, Indiana: Howard W. Sams and Co., 1974.

P-21 Wood: A Modern Structural Material, American Plywood Association, 1119 A. Street, Tacoma, WA 98401. Free.

P-22 Wood and Wood Products, Vance Publishing Corp., 300 West Adams Street, Chicago, IL 60606 - periodical.

P-23 Miller, W. R. and G. L. Steele, Plastics, Bloomington, Illinois: McKnight, 1978.

P-24 Steele, Gerald L., Exploring the World of Plastics, Bloomington, Illinois: McKnight, 1977.

P-25 Curriculum Guide for Plastics Education, Indianapolis, Indiana: Bobbs Merrill, 1977.

P-26 Cope, Dwight W. and Lee E. Schaude, Plastics, South Holland, Illinois: Goodheart-Willcox, 1977.

P-27 Jambro, Donald J., Manufacturing Processes: Plastics, Englewood Cliffs, New Jersey, Prentice-Hall, 1976.

P-28 Baird, Ronald J., Industrial Plastics, South Holland, Illinois: Goodheart-Willcox, 1978.

P-29 Swanson, Robert S., Plastics Technology, Bloomington, Illinois: McKnight, 1965.

P-30 Milby, Robert W., Plastics Technology, New York: McGraw-Hill, 1973.

P-31 Gaines, P. and W. Waite, "Elastomer Polymer Technology at $2.50 Per Student," School Shop, March, 1979, pp. 24-25.

P-32 Waite, W., "Introduce Plastics with Three Concepts in One Laboratory Activity," Industrial Education, May, 1977, p. 35.

P-33 Weede, G. and D. Leben, "A Programmed Approach to Plastics Identification," School Shop, May, 1978, pp. 26-29.

P-34 Glossary of Plastics Terms, Phillips Petroleum, Chemical Department, Plastics Division, Bartlesville, OK 74004. Free.

P-35 Levers, Carl, Industrial Arts Plastics Technology Resource Guide. Available through the Virginia Industrial Arts Association, Industrial Arts Education Service, P.O. Box 6Q, Richmond, VA 23216. Distributed at the 1978-79 summer conferences.

PROCESSING

PR-1 Johnson, Harold V., Manufacturing Processes, Peoria, Illinois: Charles A. Bennett, 1979.

PR-2 Bame, Allen E., Using Metrics in Industrial Arts, Richmond, Virginia: Industrial Arts Education Service, Department of Education, 1979.

PR-3 Feirer, John L., S. I. Metric Handbook, Peoria, Illinois: Charles A. Bennett Co., 1977.

PR-4 Selbo, M. L., Adhesive Bonding of Wood, Tech Bulletin 1512, U. S. Forest Products Laboratory. Order Stock No. 001-000-03382, Superintendent of Documents, U. S. Government Printing Office, Washington, D. C., 20402. Price $1.55.

PR-5 Wagner, Willis H., Modern Industry, Chicago, Illinois: American Technical Society, 1975.

PR-6 Wright, R. Thomas and Thomas R. Jensen, Manufacturing, South Holland, Illinois: Goodheart-Willcox, 1976.

PR-7 Soderberg, George A., Finishing Technology, Bloomington, Illinois: McKnight, 1969.

PR-8 Griffin, Irvan H., et al., Welding Processes, New York: Delmar, 1978.

PR-9 Ruby, D., "A New Family of Penetrating Finishes," Popular Science, January, 1980, pp. 85 and 158.

PR-10 Feist, William C. and Edward A. Mraz, Wood Finishing: Water Repellents... Preservatives (Research Note FPL-0124), Madison: U. S. Forest Products Laboratory, 1978. Free booklet.

PR-11 Stokes, Vernon L., Manufacturing Processes, Columbus, Ohio: Merrill Publishing Co., 1975.

PR-12 Useful Facts and Figures (finishing), Reliance Universal, 4730 Crittenden Drive, Louisville, Kentucky, 40209. Free.

PR-13 Deal, Walter F. III, "Hold It in Place with Adhesive Technology," Man/Society/Technology, December, 1979, pp. 20-22.

PR-14 Ray, Edward D., "Building a Tracker in the Solar Engine with Solar Muscle," Popular Science, February, 1980, pp. 126-128.

FILMS, SLIDES, OVERHEAD TRANSPARENCIES, ETC.

See "Sources of Information and Materials" for addresses to suppliers listed with each film. Please note that this list represents films available during the writing of this guide. Some will become unavailable but the sources often have updated replacements; request current listing.

F-1 Bodybuilders - Bureau of Teaching Materials, State Department of Education

F-2 Innovation (Part of 5 films on American Enterprise) - Modern Talking Picture Service

F-3 The Innovators - GMC through Modern Talking Pictures

F-4 Pushing the Limits - IBM

F-5 Careers in Engineering Technology - free loan from Dr. James A. Jacobs, School of Technology, Norfolk State University, Norfolk, VA 23504.

F-6 Metal Crystals in Action - American Society for Metals

F-7 Slide Series on Materials - American Society for Metals

F-8 Steelmakers - Modern Talking Pictures

F-9 United States Steel films catalog

F-10 How Steel is Made Flow Chart - free in-classroom quantities - U. S. Steel

F-11 How Coal Chemicals Are Made Flow Chart - free in-classroom quantities - U. S. Steel

F-12 How Aluminum is Made - free chart - Aluminum Association

F-13 Synthetic Rubber: Where the Action Is - Modern Talking Pictures

F-14 "Corrosion in Action," International Nickel Co.

F-15 thru F-25: Sound/filmstrips by Bobbs-Merrill Publisher

F-15 "Structure and Chemistry of Plastics"

F-16 "Polymer Structure"

F-17 "Material Identification"

F-18 "Career Guidance"

F-19 "Casting and Encapsulating"

F-20 "Coatings"

F-21 "Compression and Transfer Molding"

F-22 "Rotational Molding"

F-23 "Foam Molding"

F-24 "Thermoforming"

F-25 "Injection Molding"

Free Films from Motion Pictures, Bureau of Mines

F-26 "Arizona and Its Natural Resources"

F-27 "Nevada and Its Natural Resources"

F-28 "Oregon and Its Natural Resources"

F-29 "Washington and Its Natural Resources"

F-30 "Rubber from Oil"

F-31 "Copper, The Oldest Modern Metal"

F-32 "Cast Iron - The Biography of a Metal"

F-33 "Aluminum: Metal of Many Faces"

F-34 "The Extraordinary World of Zinc"

F-35 "Silver"

F-36 "The Minerals Challenge"

F-37 "Wealth Out of Waste"

Shell Films

F-38 "Drama of Metal Forming"

F-39 "Oil"

F-40 "Paint"

F-41 "Refinery Process"

F-42 "Rubber By Design"

F-43 Energy Film Catalog - ERDA

F-44 "Joining Plastics Parts" Du Pont

F-45 "Plastics - Industrial Processes and Products" - Du Pont

F-46 Film Catalog - National Audiovisual Center. Many films on Nature, Testing, and Processing of Materials

F-47 "Forging: Divotal Industry" - Modern Talking Pictures

F-48 "Powder Metal" - Modern Talking Pictures

F-49 "Extrusion" - Association Films

F-50 Recycling an Ecology Study Kit: sound/filmstrip and booklet, reasonable purchase price - Aluminum Association

F-51 Metalworking with Aluminium Kit - Aluminum Association

F-52 Challenge and Change: A Story of Science and Technology Kit - Aluminum Association

F-53 "Prevention and Control of Distortion in Arc Welding" - Association Film

F-54 MIG & TIG Welding Kit with sound/filmstrip and booklet, reasonable purchase cost - Aluminum Association

F-55 "PPG Glass for the 70's" - Modern Talking Pictures

F-56 "Fiber Reinforced Plastics," sound/filmstrip, Filon - free

RESOURCE PEOPLE

R-1 Educational Programs Officer
National Aeronautics and Space Administration
Langley Research Center
Hampton, VA 23665

R-2 Contact the educational officer of such local professional societies as the American Society of Metals, Peninsula Engineers Society, Society of Automotive Engineers, American Welders Society, and others listed in this guide under "Sources of Information and Materials." Request guest speakers or other assistance.

R-3 Ask for speakers and literature from Consumer Affairs, Agriculture and Commerce Department, Richmond, toll free call 1-800-552-9963.

R-4 Invite inspectors from local industry.

R-5 U. S. National Bureau of Standards, Department of Commerce, Route 270 Gaithersburg, MD 20234.

R-6 American Society of Testing and Materials, 1916 Race St., Philadelphia, PA 19103.

SUPPLIES AND EQUIPMENT SOURCES

Supplies

S-1 styrofoam balls - department stores

S-2 styrofoam atom model kits - American Society of Metals (ASM)

S-3 Experiment 11-B "Heat Treatment of Steel" - American Society of Metals

S-4 Slides on metals - ASM

S-5 Metallographic Test Specimens (General #81-1800) Buehler Limited, 2120 Greenwood Street, Evanston, IL 60204.

S-6 Specimen etchant: 2% Nital, 10% CrO_3, Kellers Reagent, Picral - HNO_3-H_2O, $K_2Cr_2O_7$-H_2SO_4, Aqua Regia - Buehler Limited

S-7 Purchase from scientific supply houses listed below: petri dishes, graduated cylinders, beakers, Pyrex reagent bottles w/glass stoppers (250 ml)

Scientific Supply Houses

S-8 Fisher Scientific, 1231 North Honroe Street, Chicago, IL 60622.

S-9 Scientific Products, 8855 McGraw Road, Columbia, MD 21045.

S-10 Thomas Scientific Apparatus, P.O. Box 779, Philadelphia, PA 19105.

S-11 Wards Natural Science, P.O. Box 1712, Rochester, NY 14603.

S-12 Edmund Scientific, Barrington, NJ 08007.

Plastics Suppliers

S-13 The Plastics School specimens, Cope Plastics Inc., 4441 Industrial Drive, Godfrey, IL 62035.

S-14 AIN Plastics, 8459 Chesapeake Boulevard, Norfolk, VA 23518.

S-15 Read Plastics, 1006 Ballentine Boulevard, Norfolk, VA 23504.

S-16 Norva Plastics, 2609 Monticello Avenue, Norfolk, VA 23517.

Also see list of general suppliers below and yellow pages of phone book.

General Suppliers

S-17 Graves-Humphrey, Inc., P.O. Box 13407, Roanoke, VA 24033.

S-18 Brodhead Garrett, 4560 East 71st Street, Cleveland, OH 44105.

S-19 IASCO, 5724 West 36th Street, Minneapolis, MI 55416.

S-20 PITSCO, Box 1328, Pittsburg, KS 66762.

S-21 Technovate Incorporated, 910 S.W. 12th Avenue, Pompano Beach, FL 33060 - Mechanics of Materials Learning System (Mod. 9014).

Laboratory Equipment

L-1 bench metallograph

L-2 metal specimen polisher from Buehler S-5

L-3 Mechanics of Materials Learning System - Model 9014 from S-21, Technocate Inc.

L-4 Materials Processing Center - Model 9013 from S-21 Technovate, Inc.

AMERICAN INDUSTRIAL ARTS STUDENT ASSOCIATION

General

A-1 Van Dyke, Arvid, Student Association Activities in Industrial Arts Instruction, Virginia Department of Education, Richmond, 1979.

Leadership Development Activities

A-2 AIASA Student Handbook, American Industrial Arts Student Association, 1206 16th Street, N.W., Washington, D.C. 20036.

A-3 Advisors Handbook, Industrial Arts Education Service, State Department of Education, P.O. Box 6Q, Richmond, VA 23216.

A-4 Officers Handbook, Same address as above.

A-5 How to Conduct a Meeting, (16 mm movie, Computer #04606), Bureau of Teaching Materials, State Department of Education, Richmond, VA 23216.

A-6 Parliamentary Procedures in Action, (16 mm movie), check local, regional or state film libraries.

A-7 Gavel, Notebooks and Officer Pins, Order from Balfour Supply Service, Inc., 11722 Parklawn Dr., Rockville, MD 20852.

A-8 Roberts, Henry M., Roberts' Rules of Order, Same address as above.

A-9 Ribbons and Leadership Materials, (Request Current Catalog), Crestline Company Inc., 18 West 18th Street, New York, NY 10011.

A-10 Jones, Garfield O., Parliamentary Procedure at a Glance, Hawthorn Books, Inc., 260 Madison Ave., New York, NY 10016.

A-11 Officer Training Filmstrip, (With Cassette Tape), Leadership Development Institute, 1424 Liberty Avenue, Stillwater, OK 74074 (Ask Price).

A-12 Leadership Activity Guides, Same address as above.

A-13 Guide to Parliamentary Procedures, (Filmstrip), Colonial Films, Inc., 71 Walton St., N.W., Atlanta, GA 30303.

A-14 AIASA Officer Symbols, Plans are in AIASA Student Handbook or to purchase, contact the AIASA National Office.

A-15 Rules of Order, (Sound Filmstrip Series #6467), Encyclopaedia Britannica Educational Corp., 425 N. Michigan Ave., Chicago, IL 60611 (Check local or college media centers for availability).

A-16 Prepare Student Vocational Organization Members for Leadership Roles, (Module H-3), American Association for Vocational Instructional Materials, 120 Engineering Center, Athens, GA 30602.

Industrial and Community Resource Activities

A-17 Pinelli, Thomas E. and Myron W. Curtis, "The Community as a Resource for Industrial Arts," Man/Society/Technology, American Industrial Arts Association, 1206 Sixteenth Street, N.W., Washington D.C. 20036 (December, 1974, pp. 81-84).

A-18 Films, Speakers, Career Information, Tours or Judges, Contact nearest military recruiter of the U. S. Army, Air Force or Navy.

A-19 Community Directories of City or County Services, Request one if available from your City Hall or County Courthouse.

A-20 Industry/Business Directory, Request from local Chamber of Commerce.

A-21 A Guide for the Organization and Operation of Local Advisory Committees for Vocational Education, Division of Vocational Education, State Department of Education, P.O. Box 60, Richmond, VA 23216.

A-22 Finding the Right Speaker, How, When, What, Where and Who (1977, $10.00), American Society of Association Executives, 1101 Sixteenth Street, N.W., Washington, D.C. 20036.

A-23 Writing Different Kinds of Letters, (16 mm movie), Bureau of Teaching Materials, State Department of Education, Richmond, VA 23216.

School and Community Service Activities

A-24 Civic and Community Activities in AIASA Student Handbook, American Industrial Arts Student Association, 1206 Sixteenth St., N.W., Washington, DC 20036.

A-25 Childcraft Catalog of Toys that Teach, Childcraft Educational Corp., 20 Kilmer Road, Edison, NJ 08817.

A-26 Consumer Information, (Catalog of publications about products), Consumer Information Center, Public Documents Center, Pueblo CO 81009.

A-27 Directory of Safety Posters, National Safety Council, 425 N. Michigan Avenue, Chicago, IL 60611.

A-28 Easter Seal Society Annual Report, (Contact Nearest Office), Easter Seal Society of Virginia, 4841 Williamson Rd., Roanoke, VA 24012.

A-29 Directory of Reynolds Recycling Centers also Questions and Answers, Public Relations Manager, Reynolds Aluminum Recycling Co., 6603 West Broad St., Richmond, VA 23261.

A-30 Information and Ideas to Keep Your Community Beautiful, Keep Virginia Beautiful, Inc., 110 East Franklin Richmond, VA 23219.

A-31 Litter Control Film List, Virginia Division of Litter Control, Box 1515, Richmond, VA 23212.

A-32 Safety Film Catalog, (List many films to show as service to others), Industrial Safety Division, P.O. Box 1814, Department of Labor, Richmond, VA 23214.

A-33 Tips for Energy Savers, (Booklet of Conservation ideas for home, car or business), Consumer Information Center, Public Documents Center, Pueblo, CO 81009.

A-34 Aids and Appliances Catalog, (Ideas for projects to assist persons with low or no vision), American Foundation for the Blind, 15 West 16th Street, New York, NY 10011.

A-35 Suggested Commemorative Activities for Public Schools in Virginia, Public Information Office, State Department of Education, P.O. Box 6Q, Richmond, VA 23216.

Product or Service Enterprise Activities

A-36 Catalog of School Sale Items, (Approved by National AIASA), Ring Fare, Inc., 7432 Washington Street, Pittsburgh, PA 15218.

A-37 The American Economic System and Your Part in It (#597E), Consumer Information Center, Public Documents Center, Pueblo, CO 81009.

A-38 School Spirit items for resale (Buttons, banners, and bumper stickers), Request catalog from company, Crestline Company, Inc., 18 West 18th Street, New York, NY 10011.

A-39 Industrial Arts Guide for Exploring Technology (Guide to Unit, Group and Line Production methods), Industrial Arts Education Service, State Department of Education, P.O. Box 6Q, Richmond, VA 23216.

A-40 Making that Sale (16 mm movie), Check local, regional or community college media centers for a copy to borrow.

A-41 Assist Student Vocational Organization in Developing and Financing a Yearly Program of Activities (Module H-4), American Association for Vocational Instructional Materials, 120 Engineering Center, Athens, GA 30602.

A-42 Industrial Development, (Explains how new industry is attracted to a community), Virginia Division of Industrial Development, 1010 State Office Building, Richmond, VA 23217.

A-43 List of Gift Catalogs, (Request list to obtain free catalogs for project ideas), Industrial Arts Curriculum Resources, Box 449 Va. State University, Petersburg, VA 23803.

A-44 Ways & Means Handbook (A Guide to money making projects #342), *Consumer Affairs Distribution Center, The Sperry & Hutchinson* Co., 2900 West Seminary Dr., Ft. Worth, TX 76133.

A-45 Let's Make Money for Everyone etc., (Video Programs #4 to 7 in Industrial Arts for the 70's Series), Bureau of Teaching Materials, State Department of Education, P.O. Box 6Q, Richmond, VA 23216.

A-46 An Introduction to American Industry (Booklet and transparencies), DCA Educational Products, Inc., 4865 Stenton Ave., Philadelphia, PA 19144.

Achievement Recognition Activities

A-47 Trophies, jewelry, award certificates, pins, and plaques. Request list of AIASA items from: Balfour Supply Service, Inc., 11722 Parklawn Drive, Rockville, MD 02852.

A-48 National Conference Slides (80 per tray, borrow or purchases), American Industrial Arts Student Association, 1201 16th Street, N.W., Washington, D.C., 20036.

A-49 National Conference Information Packet, American Industrial Arts Student Association, 1201 16th Street, N.W., Washington, D.C. 20036.

A-50 AIASA Competitive Events (Rules and Entry Forms), American Industrial Arts Student Association, 1201 16th Street, N.W., Washington, D.C. 20036.

A-51 The Virginia School Scene and The AIASA School Scene (State and national newsletter which will use local news), Mail news articles and photos to: Virginia AIASA, 1201 16th Street, N.W., Washington, D.C. 20036.

A-52 Metric 500 Instructions and Kits, PITSCO, Inc., Box 1328, Pittsburg, KS 66762.

A-53 Publicity Handbook, Copyright 1978, The Sperry and Hutchinson Company, 330 Madison Avenue, NY 10017.

A-54 Newspaper articles and photographs which recognize student achievements. Use local newspapers or organization newsletters.

A-55 Promotional ideas for National Industrial Arts Education Week in November, American Industrial Arts Student Association, 1206 16th Street, N.W., Washington, D.C. 20036.

A-56 Publicity materials for Vocational Education Week, American Vocational Association, 2020 N. 14th Street, Arlington, VA

A-57 Public Speaking Fundamentals (16mm movie, Computer #70609), Bureau of Teaching Materials, State Department of Education, 1322-28 E. Grace Street, Richmond, VA 23216.

A-58 Public Information (A Guide for Vocational Educators), Division of Vocational Education, State Department of Education, P.O. Box 6Q, Richmond, VA 23216.

EXPERIMENTS, ACTIVITIES, AND PROJECTS

EXPERIMENTS, ACTIVITIES, AND PROJECTS

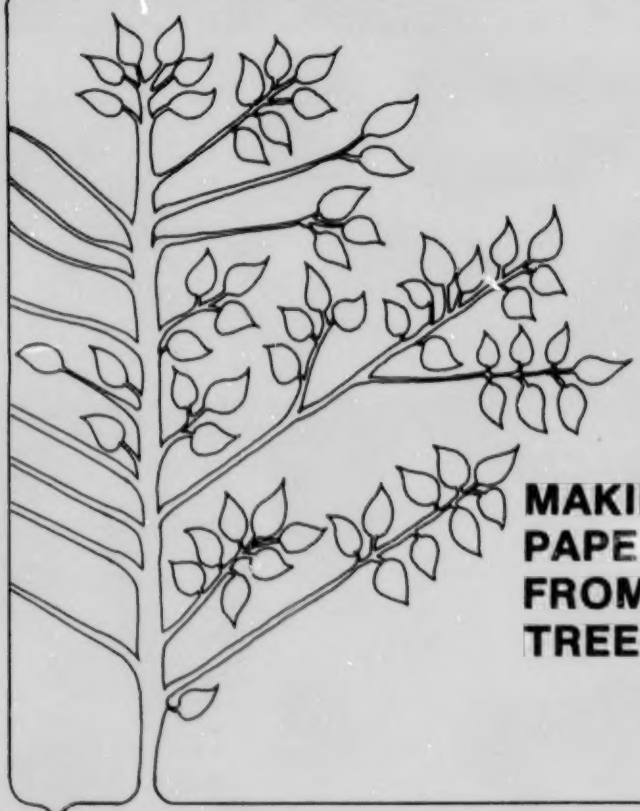
There are many examples of easily constructed devices for testing and processing materials in such periodicals as School Shop and Industrial Education. A few examples follow:

"Falling Dart Impact Testing," Industrial Education, November, 1979, pp. 58-59.
"A Programmed Approach to Plastics Identification," School Shop, May, 1978, pp. 26-29.

Some textbooks give plans for testing devices such as Woodworking for Industry by John L. Feirer (Charles A. Bennett, Co.), Industrial Materials Technology by James A. Jacobs and Thomas F. Kilduff (Gatling Printing and Publishing), and Classroom Demonstrations of Wood by A. N. Foulger (U. S. Forest Products Laboratories).

The activities which follow in this guide include materials and ideas offered to the author by several projects:

"Engineering Curriculum Activities," from College of Engineering, University of Washington, Seattle.
Summer Workshop for "Suggested Student Activities for Technically Oriented Materials and Processes," University of West Florida.
NDEA Title II Institute for Advanced Study in Industrial Arts at San Jose State College, San Jose, California.



MAKING PAPER FROM TREES

Paper has been a key factor in the progress of civilization, especially during the past 100 years. Paper is indispensable in our daily life for many purposes. Among these modern uses of paper are to spread the printed and written word, and to wrap, package, and ship goods — from foods and drugs to clothing and machinery. Paper conveys a fantastic variety and volume of messages and information of all kinds via its use in printing and writing — personal and business letters, newspapers, pamphlets, posters, magazines, mail order catalogs, telephone directories, comic books, school books, novels, etc.

It is difficult to imagine the modern world without paper. We use it as wrappers or containers for milk, ice cream, bread, butter, meat, fruits, cereals, vegetables, potato chips, and candy; to carry our food and department store purchases home in; for paper towels, cellophane, paper handkerchiefs and sanitary tissues; for our notebooks, coloring books, blotting paper, memo pads, holiday greeting and other "special occasion" cards, playing cards, library index cards; for the toy hats, crepe paper decorations, paper napkins, paper cups, plates, spoons, and forks for our parties.

Paper is used in building our homes and schools — in the form of roofing paper, and as paperboard — a heavy, compressed product made from wood pulp — which is used for walls and partitions, and in such products as furniture. Paper is also used in linerboard, "cardboard," and similar containers.

So essential is paper in our daily life that we probably could not maintain our civilization at its present level without wood pulp. It is the principal fibrous raw material from which paper is made.

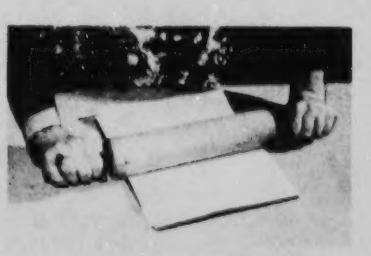
HOW YOU CAN MAKE PAPER

Step 1. — Tear 30 sheets of facial tissue and place in basin. Mix one tablespoon of instant starch in two cups of water and add water to make about 10 quarts. Beat until thoroughly mixed.

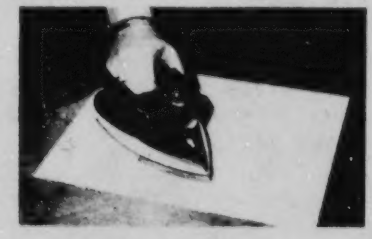
Step 2. — Prepare the paper machine, consisting of pan, screen, and form rack.

Step 3. — Hold forming rack firmly on the screen and dip sidewise into the pulp mixture.

Step 4. — Clean off the excess pulp outside forming rack. Lift out the screen on which the pulp has formed.



Step 5. — Dry the screen and wet sheet of pulp between two pieces of blotting paper. The sheet will stick to them. Press out excess water with rolling pin.



Step 6. — Finally, iron-dry (not too hot) the sheet still between the blotters. Trim the edges with scissors. You now have a sheet of handmade paper.

Here Are Some Tests You Can Apply to Paper

Tear a corner of this sheet and compare the length of the fuzzy white fibers with those in a sheet from your notebook torn the same way. Notice which sheet tears easier. Also, try folding each sheet at one spot, and keep refolding at the same line. Which paper holds up best? Hold a sheet of each up to a window or electric light. Which can you see through best? Compare the smoothness or roughness (texture) of the two types of paper. Try writing on the sheet with a pen. Do these same tests with a paper napkin, paper towel, a road map, and the "window" from a business envelope. These are basic commercial tests for different grades of paper. They will show you how different papers made for different uses vary from one another. Remember, 97 percent of all paper comes from trees in the forests.

FOREST PRODUCTS LABORATORY FOREST SERVICE U.S. DEPARTMENT OF AGRICULTURE

115

☆ U.S. GOVERNMENT PRINTING OFFICE: 1978 — 753-367

STUDENT PRODUCT/SYSTEM DESIGN

THE CHALLENGE: Apply your knowledge of the nature, properties, and processability of materials in the design of a product or system of your selection.

*THE APPROACH:

1. Write a statement of the problem.
   Examples: Design a solar heating and storage system to provide hot water for a single family dwelling.
   Design a bicycle trailer to transport a surfboard.
   Design a study desk to be cut from a single 4' x 8' sheet of plywood with drawers and attachments to be of non-wood based materials.
   Design a study lamp that will mount on both a desk and bed.
   Design a habitat to support a group of scientists living under the ocean.
   Design an experiment for materials testing outdoor weatherability or to fly on the LDEF (Long Duration Effects Facility) project connected with the NASA Space Shuttle.
   Design a lightweight fuel efficient automobile to carry two passengers.

2. Research the project in industrial arts texts; periodicals such as Popular Science, School Shop, or the Smithsonian; encyclopedias; and other references.

3. Draw the conceptual design as sketches and instrumental drawings. Draw many sketches and save them. Specify the materials with a statement on why they were selected. Explain the processes used to cut, form, and join the materials.

4. Discuss the design with your parents, classmates, instructor, and knowledgeable people who are interested in your project.

5. Refine your conceptual design based on the feedback you received. Make the final working drawings.

6. Construct a prototype or model of the product or system. Keep track of cost. Test your prototype and make improvements.

7. Present your product or system to the class in a sales presentation. They are the customers. Have each student say whether or not he/she will buy your product/system for your asking price and explain their choice.

8. Enter your prototype or model in the AIASA Spring Festival.

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* Refer to such books as G-12 for explanation of the design process.

CONDUCTORS

Are all metals equally good conductors?

Try this experiment with heat conduction:

Take a rod of Aluminum
of Steel
and of Copper

Place one end of each rod in boiling water.

Measure how long it takes for the other end of each rod to get hot,

then

Classify these metals from fastest to slowest conductor.

WOULD YOU BELIEVE that heat conduction in metals is determined by electron movement in the same manner as electrical conduction?

What does this mean about the relative electrical conductivity of these metals?

A STEP* on Properties of Materials

by

James A. Jacobs, Ed.D.

c 1978

XXXX

6. Given a tape recorder, tape, and permanent magnet, demonstrate the effect of a magnet on a tape recording and explain the basic principle of recording tapes.

Magnetization or the ability of a metal to be magnetized does not involve adding or subtracting particles, rather the rearranging of small internal magnets known as domains. At the subatomic level, a material's ability to be magnetized (permeability) depends on the spin of electrons. As electrons spin either clockwise or counterclockwise on their axis (Figure 1) while orbiting the nucleus, electrons in the outer shells affect a material's permeability.

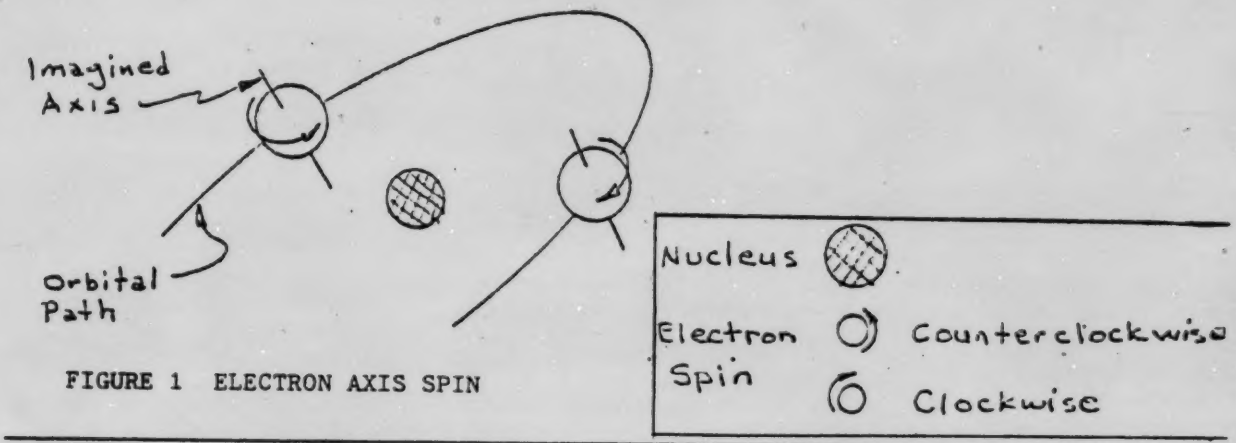


FIGURE 1 ELECTRON AXIS SPIN

Among the measures of magnetization are the properties of ferromagnetism, diamagnetism, paramagnetism, ferrimagnetism, and antiferromagnetism; this coverage is limited to ferromagnetism.

A ferromagnetic material has the ability to possess magnetic lines of force or flux without an outside magnetic field; external magnetic fields induce the magnetism and increase it. Iron is ferromagnetic as are nickel, cobalt, some rare earth elements, and a variety of alloys. A study of iron at the subatomic level reveals an unbalanced spin (Figure 2) in the outer shell of electrons (3d orbital); whereas copper has balanced directional spins (Figure 2 c).

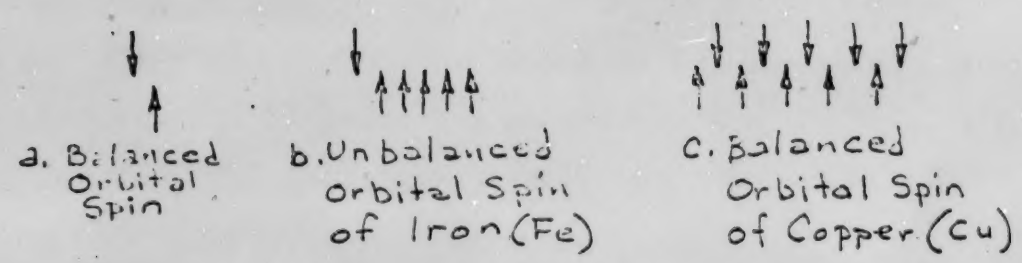


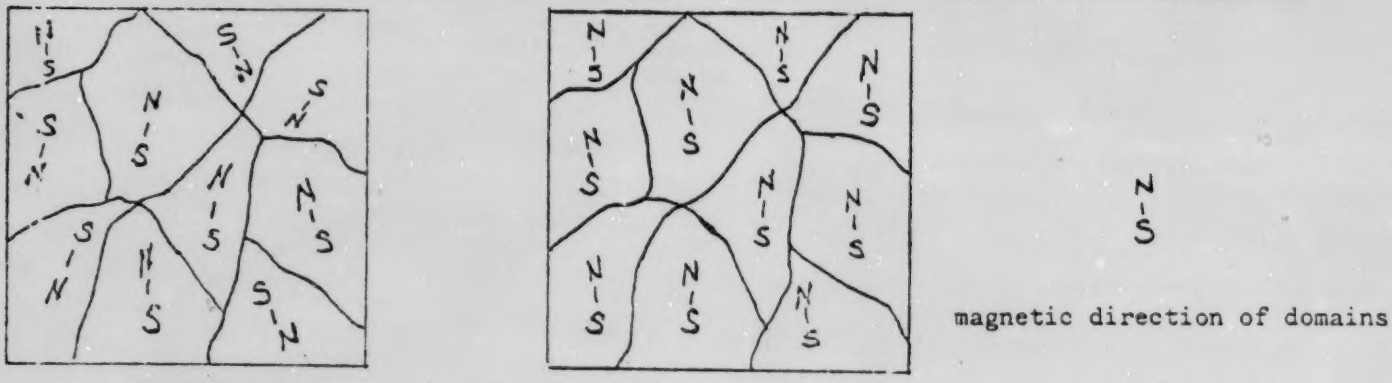
FIGURE 2 ORBITAL SPIN OF AN ATOM

At the critical temperature known as Curie temperature, a ferromagnet will lose its magnetism due to changes in atomic alignment. The Curie point for iron is 1043° K, nickel is 631° K, and cobalt is 1393° K.

ANSWER QUESTIONS ON SCRAP PAPER. PLEASE DO NOT MARK IN THIS BOOKLET.

QUES. 1. How does the balance of electrons in the outer shell of ferromagnetic materials differ from other materials? List these ferromagnetic materials.

Above the atomic level ferromagnets possess orderly regions known as domains. Domains have a general magnetic alignment of the atoms (Figure 3 a) creating tiny internal magnets. When demagnetized, atoms within domains align, but domains tend to be magnetically apposed. When an external magnetic field is applied the domains align (Figure 3 b) giving the material definite north/south magnetic poles.



a) domains of demagnetized material

b) domains after external magnetic force applied

FIGURE 3 DOMAINS OF MAGNETS

QUES. 2. For a ferromagnetic material to be magnetized, what must be the arrangement of the domains?

The classifications of hard and soft magnets are of special significance in

electric power generation. Soft magnets can be magnetized and demagnetized with a relatively low amount of applied electrical force. Magnetization is accomplished by placing the material in an electric coil (Figure 4) as found in electrical power transformers. Hard magnets or permanent magnets will retain much of their magnetism when the external field has been removed, whereas soft magnets give up their magnetism.

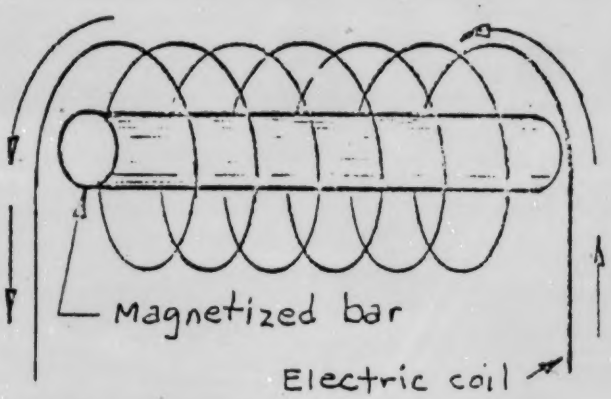


FIGURE 4 MAGNETIC FIELD

With a hysteresis loop (Figure 5, page 5) shows how magnetization (B) is increased in a material as a field (H) is applied. Starting at 0 there is no current nor magnetization; as H is applied B increases until the current peaks (a); B decreases as the current is removed but does not return to 0 instead retains some magnetization (b). A change in current polarity causes further demagnetization until the material is neutral, then continuing a change in domain direction until the current is again reversed (d) causing a B increase until it peaks (a).

Figure 5a shows a large area within the hysteresis loop. Such a metal is a hard magnet and requires expensive electrical energy (H) to operate. A soft magnet requires less energy (H) to produce equal magnetism (B) as seen by the smaller hysteresis loop (Figure 5 b). Alloying elements including aluminum, cobalt, chromium, copper, and tungsten to iron produces good permanent magnets such as Alinco magnets. Silicon is a key element that is added to iron for preventing hysteresis loss or for making it a soft magnet. Many other structural changes affect magnetization including arrangement of metal grains, uses of insulating elements, and changes of particle sizes.

QUES. 3. Why are soft magnets necessary as cores or centers in transformers?

Magnetism Experiments

1. Permeability of materials

   From your professor, obtain specimens of plastic, copper, aluminum, iron, and steel and a permanent magnet. Use the magnet to separate materials that have permeability from those that don't. Which materials are ferrous? Explain.

2. Degrees of Magnetic Hardness

   Obtain insulate copper wire, two flashlight batteries, steel weights, and steel rods. Coil the copper wire around a ball point pen or pencil. Tape the batteries one on top of the other. Attach ends of wire to top and bottom of the battery. Place each rod into the coil, pick up the maximum weight for each rod. Rank each rod's magnetic ability. Remove the rod from the coil and test its magnetic strength. Explain the differences in degrees of hardness of the magnets.

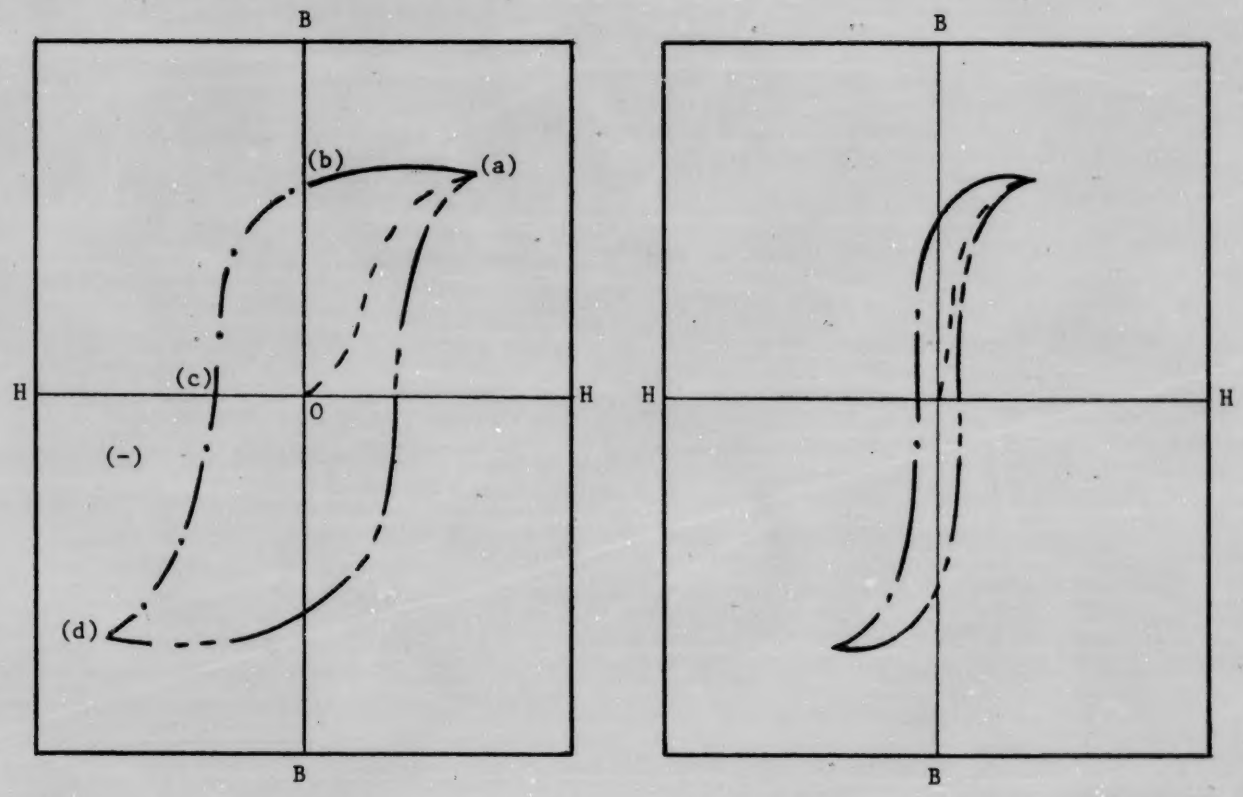
3. Magnetic tape

   Obtain a tape recorder, tape, and permanent magnet from your instructor. Make a recording and listen to it. Rub the magnet on a section of the tape. Play the tape to see if there is a change in the recording. Explain how the recording was made and how the magnet affected the tape.

CAUTION: DO NOT MAKE CONTACT OF THE MAGNET WITH THE TAPE RECORDER!

ANSWERS TO SELF-TEST

1. see paragraph 2 page 2. iron, nickel, cobalt.
2. Must be aligned so they have the same north/south magnetic poles.
3. Hysteresis loss is loss in soft materials so they require less energy than hard magnets to be demagnetized.



0 no magnetization (B=0) & no current (H=0)

——·—— change of current polarity (-) removes magnetization

— — — applied current causes magnetization

—— -- —— change in polarity (+) increases magnetization

——— current removed but some magnetization

FIGURE 5 HYSTERESIS LOOP

MAGNETIC TRANSPARENCY

Equipment and supplies: Bar magnet, water, a glass jar or beaker, aluminum pan, tack, tin can lid, dictionary

Procedure: Carefully lower a bar magnet into a beaker of water.
Put a tack on the table and
Hold the beaker over the tack.
What happened to the tack?

Now tape the lid from a "tin" can on the bottom of a beaker and try again.

Remove the magnet from the beaker and put in the aluminum pan. Hold the pan over the tack and see what happens.

Look up the word "transparent" in the dictionary. Re-write the definition so that it will apply to magnetism. What is a magnetically transparent material?

Is water magnetically transparent? How do you know?

Is aluminum magnetically transparent? How do you know?

Is steel?

Do you think that air is magnetically transparent? What makes you think so?

FUSES

Fuses in our electric wiring system protect the house wiring from becoming overheated by making use of electrical resistance.

Just beneath the window in a fuse is a piece of metal with a comparatively low melting point that melts and breaks the circuit when there is a sudden upsurge of current or a short circuit. Examine a fuse.

To demonstrate the principle of a fuse, obtain some of the thinnest aluminum foil possible and cut a strip as shown.

Using this foil, a wire, and a flashlight battery, make a circuit. Allow the current to pass through until you see a change in the aluminum. What happens?

The point at the center should be as narrow as possible to obtain results since your battery does not deliver a great deal of current.

What other safety devices are used in houses?

What is in your home to prevent electrical fire?

PAPER CLIPS

Bend a paper clip back and forth in the same manner and count how many bends it takes to break each clip.

Make a histogram by drawing a number line on the board and have each student make an x above the number of bends it takes to break each clip. (See line below)

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18

Does each clip break after the same number of bends?

What is the range?

What is the average number of bends needed to break a paper clip?

Try different types of paper clips and find out which ones are the strongest.

TITLE: EXPANSION AND CONSTRUCTION TEST APPARATUS

I INTRODUCTION

All of us have viewed expansion, contraction, and the allowances made for these phenomenon in our everyday lives whether or not we are knowledgeable of the fact. The spacing in bridges, the "U" shapes in pipes often seen in industry, the valve gap and ring end gaps listed in specifications for engines, the creeking in a house or other structure as the day cools off, the "noisy" radiator in buildings, all of these and many more such examples are evidence of the need for and the application of efforts to utilize and allow for expansion and contraction of materials. Efforts must be made to point out to students of materials the "why" of this phenomenon.

II OBJECTIVES

A. To demonstrate how materials expand and contract.
B. To teach why a person involved with materials must have an awareness of this phenomenon.

III MATERIALS AND EQUIPMENT

A. Expansion and contraction test apparatus. (see attached sketch)
B. Metal test strips.
C. A source of heat.
   a. Oven
   b. Oxy-acetylene torch unit
D. A source of cold.
   a. Dry ice

IV UTILIZATION IN THE TEACHING-LEARNING ENVIRONMENT

A. SAFETY

Since heat in various forms is used, care must be exercised to see that proper procedures are followed for the apparatus involved. Caution must also be exercised in the handling of the heated metal test strips. All flammable materials must be removed from the test area.

B. PRESENTATION

1. LECTURE-DEMONSTRATION

The teacher will place a piece of test metal in the apparatus and heat the strip with the torch and record the amount of expansion on the scale. The thickness and width of the expanded piece should also be recorded and a comparison should be made with the original size. The same procedure will be followed using cold applications.

C. OBSERVATIONS AND CONCLUSIONS

1. QUESTIONS TO BE ANSWERED DURING EXPERIMENTS
   a. Why does the metal expand and contract?
   b. Where are allowances made for expansion and contraction of materials due to heat and cold?
   c. What caused the needle to deflect?
   d. What will the micrometer readings show?

2. AREAS FOR FURTHER STUDY
   a. Theory behind fits and tolerances.
   b. Study the design features that have to be considered in the construction industry if proper regard for expansion and contraction of materials is to be considered.
   c. Study ways to utilize this phenomenon in automotive engines.

V. DEFINITION OF TERMS

A. The following terms should be explained before, during and after the demonstration.

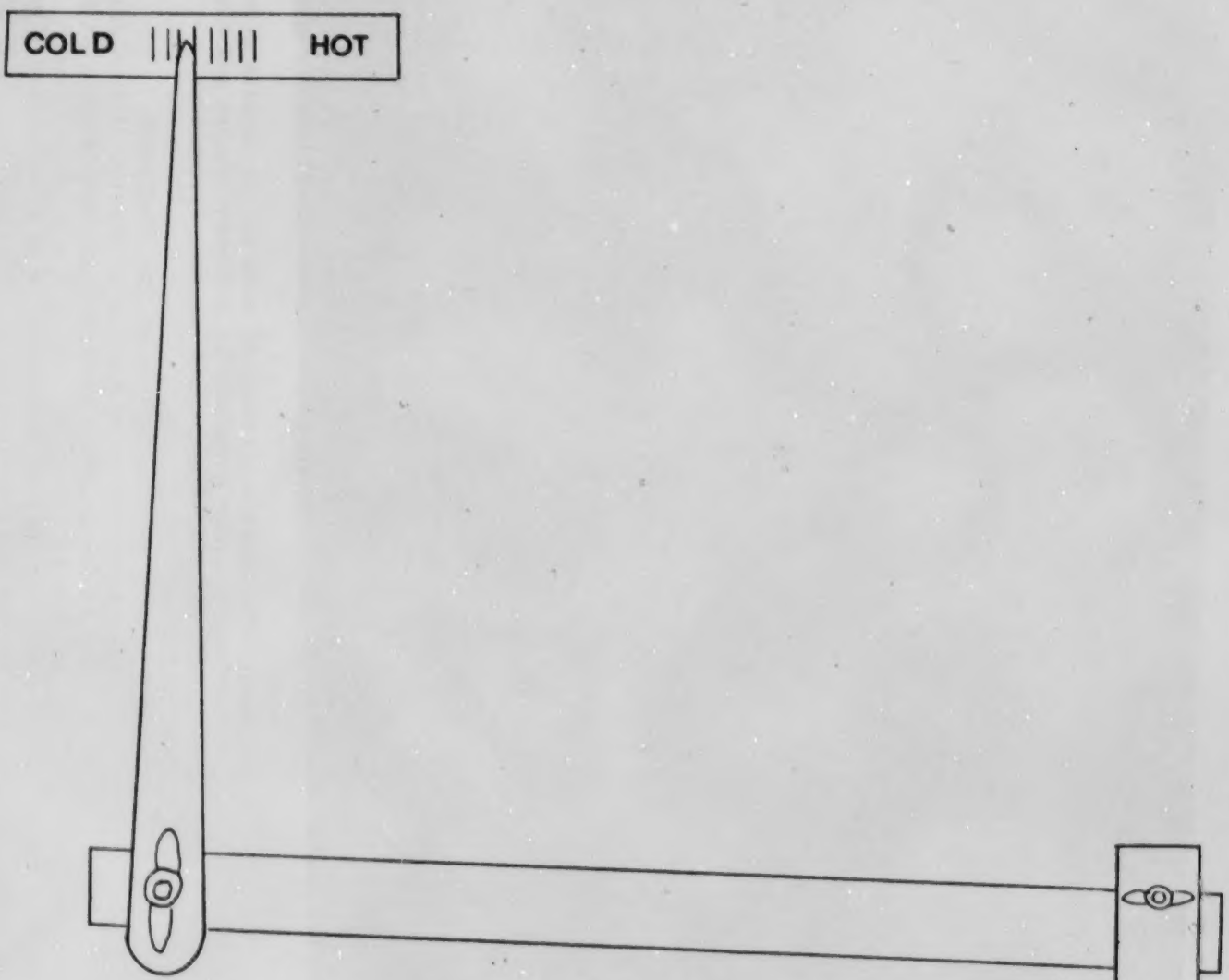
1. Ductility - The capacity of a metal for being drawn out.

2. Malleability - The ability of metal to be hammered or rolled out without breaking or cracking. The metal will become hard.

3. Conductivity - The ability of metal to carry heat.

VI. REFERENCES

Earl, Arthur, Experiments With Materials and Products of Industry, Bloomington, Illinois: McKnight and McKnight, 1960.



Metallic Expansion

TITLE: TENSILE STRENGTH TESTER

I INTRODUCTION

Tensile strength is an important property because the higher the tensile strength, the stronger the material. This type of information provides an indication of how the material may be used to the best advantage during manufacturing. The tensile strength of a material also indicates how the material is to be used. An example of this would be choosing an aluminum printing plate, instead of a paper plate, for a long run.

II OBJECTIVES

A. To observe the difference in the tensile strength of various wires.
B. To show that the tensile strength can determine the manufacturing process.

III MATERIALS AND EQUIPMENT

A. Tensile strength tester (see attached copy)
B. Wire made of various metal (copper, aluminum, soft iron, etc.) Use various gage sizes.
C. A recording form.

IV UTILIZATION IN THE TEACHING-LEARNING ENVIRONMENT

A. SAFETY
   1. Be sure plexiglass shield is in place to eliminate injuries when the wire fractures.
   2. Clamp the scale securely to eliminate damage.
   3. Wear safety glasses.
B. PRESENTATION
   1. Demonstrate tensile tester with various wires.
   2. Explain tensile strength and its relationship to manufacturing wire.
   3. Relate the tensile strength of wire to the tensile strength involved in other materials of different shapes and sizes.
   4. Explain elastic, plastic and fracture differences.
C. OBSERVATIONS AND CONCLUSIONS
   1. QUESTIONS TO BE ANSWERED DURING THE EXPERIMENT
      a. Can tensile strength provide indication of ductility?
      b. Why is tensile strength important when manufacturing an object?
      c. Does the tensile strength of a material indicate how it may be utilized?
   2. AREAS FOR FURTHER STUDY
      a. How may tensile strength be related to boating? Surfing?
      b. Is tensile strength an important factor in drafting pencils? Why?
      c. What characteristics of a material can a graph on tensile strength show?

V DEFINITION OF TERMS

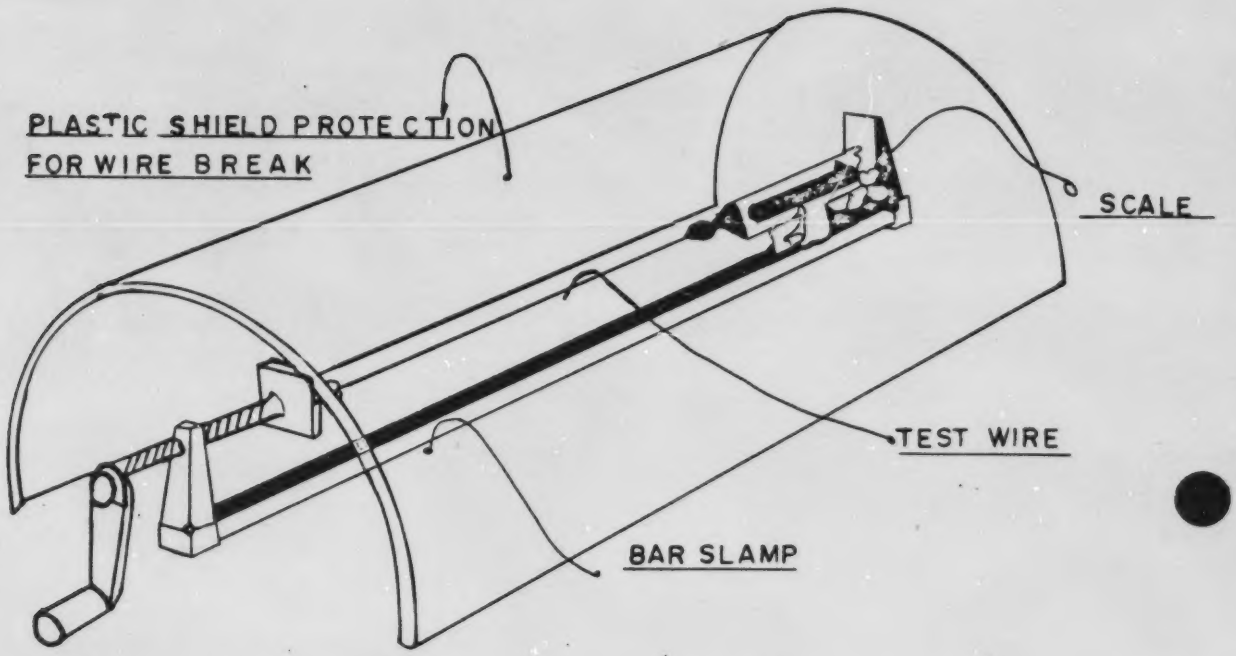
A. Tensile strength - the amount of pressure needed to fracture a material.
B. Elasticity - nonpermanent deformation. The ability of a material to return to its original shape after it has been deformed.
C. Plasticity - the ability to be permanently deformed without fracture.
D. Fracture - a permanent breaking of a material.
E. Ductility - the ability to be stretched before breaking (plastic deformation)

VI REFERENCES

Van Vlack, Lawrence; Elements of Materials Science; Reading, Mass: Addison-Wesley Pub. Co., Inc. 1966. pages 3-6, 139-148, 158-160.

ASTM; American Society for Testing and Materials, Philadelphia, Pa.: 1961, pages 165, 294, 322.

TENSILE STRENGTH OF WIRE



M.A.H

TITLE: ELASTICITY TESTER

I INTRODUCTION

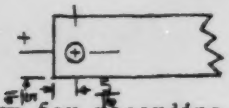
Elasticity is an important property because the more elasticity a material has, the more it may be bent and stretched without deforming. This information provides an indication of how a material may be used to its best advantage. An example of this would be choosing a steel with high elasticity when constructing a bridge or making a spring, as opposed to choosing a low elastic material, such as cast iron, for machine stands which are not subject to flexing.

II OBJECTIVES

A. To determine the elastic range of various materials
B. To show the difference in the pressure needed to deform various materials
C. To illustrate the difference between elasticity, plasticity, and fracture

III MATERIALS AND EQUIPMENT

A. Elasticity tester - see drawing attached
B. Various materials samples - 8" long and 5/8" wide with a 13/64" hole drilled in one end



C. A form for recording results
D. A suggested list of materials for testing may include sheet metal, plastic, tile, formica, glass, vinyl tile, veneer, celotex, etc.

IV UTILIZATION IN THE TEACHING-LEARNING ENVIRONMENT

A. SAFETY
   1. Do not use materials thicker than ½"
   2. De-burr all metal samples
   3. Wear safety glasses when fracturing materials
B. PRESENTATION
   1. Prepare samples for demonstration
   2. Demonstrate the use of the equipment using various samples
   3. Emphasize the difference between elastic, plastic, and fracture points
   4. Supervise a student performing the test during the lecture
C. OBSERVATIONS AND CONCLUSIONS
   1. QUESTIONS TO BE ANSWERED DURING THE EXPERIMENT
      a. What is the difference between elasticity and plasticity?
      b. Do all materials have elasticity?
      c. Why is elasticity and plasticity important when bending metals?
      d. Can "spring back" be explained by the above information?
   2. AREAS FOR FURTHER STUDY
      a. Why is elasticity an important factor in the mass production of metal parts?
      b. Why is fracture point important to a building designer?

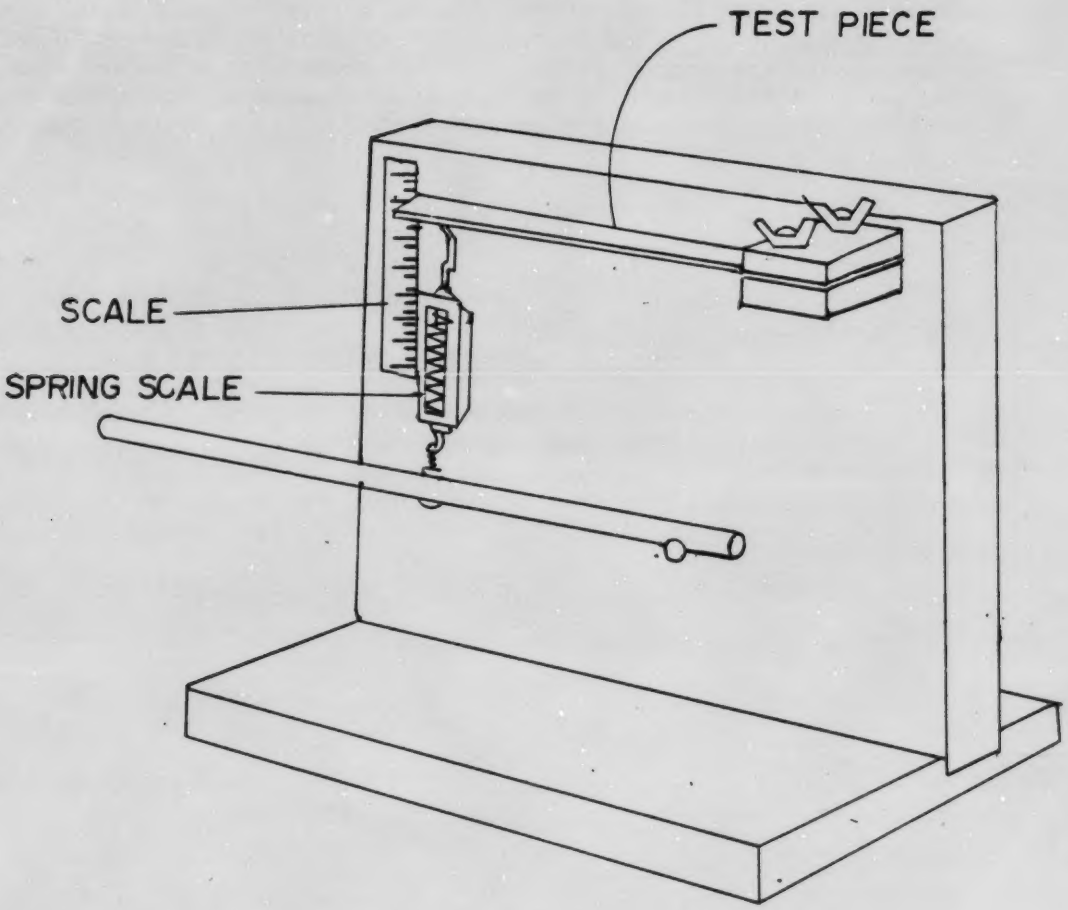
V DEFINITION OF TERMS

A. Elasticity - nonpermanent deformation. The ability of a material to return to its original shape after it has been deformed.
B. Plasticity - the ability to be permanently deformed without fracture.
C. Fracture - a permanent breaking of a material.
D. Spring back - the elastic quality remaining in a material after it has been deformed.

VI REFERENCES

A. Van Vlack, Lawrence, Elements of Materials Science, Reading, Mass: Addison-Wesley Pub. Co., Inc. 1966. pages 139-149, 156-160.
B. Earl, Arthur W., Ed D, Experiments with Materials and Products of Industry, Bloomington, Ill: McKnight & McKnight, 1960. pages 215-225, 272-275, 318-323.
C. ASTM Standards, American Society for Testing and Materials, Philadelphia, Pa. 1961. pages 158, 165.

ELASTICITY TESTER



C.M.O

TITLE: TORSION TESTING DEVICE

I INTRODUCTION

Various materials are often placed under a twisting load or torsion. Common examples are found in automobile torsion bars, torque tubes, crank shafts and axles. Students in the automotive or metals area, should be familiar with the definition of torsion and the material best suited for torsion applications.

II OBJECTIVES

A. To demonstrate the difference between elasticity and plasticity.
B. To determine elastic limit.
C. To familiarize students with stress and strain.
D. To determine the effect of cross-sectional area on the resistance to torsion.
E. To discover torsional resistance of different materials.

III MATERIALS AND EQUIPMENT

A. A stationary gripping head on one end of the device and a movable gripping head on the other (see sketch).
B. A degree scale or another method for measuring the amount of deflection and a means of applying a load are the major components of the machine.
C. A selection of various materials of different diameters.

IV UTILIZATION IN THE TEACHING-LEARNING ENVIRONMENT

A. SAFETY

Certain materials, when placed under torsional stress, exhibit a very short elastic range. These brittle materials fracture very easily sending small particles flying in all directions. It is therefore recommended that a fine wire mesh be placed over the machine when brittle materials are tested.

B. PRESENTATION

1. LECTURE DEMONSTRATION

The torsion testing machine may be used to demonstrate a property of material through testing and experimentation. Before the students are allowed to use the machine, the instructor should make clear the properties of stress, strain, elasticity, and plasticity. The students should be asked to record their findings and plot various stress vs. strain graphs.

By carefully applying and releasing the stress and gradually increasing the amount of stress in grams, the exact point at which the material will lose its elasticity may be determined. The stress is applied by clamping the material between the two chucks and applying torsional force by adding weights to the ring at the end of the lever arm. The machine may be redesigned and the torsional force applied with a torque wrench at the movable chuck. The resulting amount of deflection in degrees may be stated as follows:

"__x__ degrees of strain resulting from __y__ foot pounds of stress." To obtain the stress in foot-pounds, the distance from the center of the material under stress to the center of the force applied should be one foot.

Due to the limited amount of grip that a drill chuck will apply, it is recommended that material of ¼" diameter or less be tested.

The weight applied may be standard scale weights, pre-measured amounts of sand, or increasing amounts of water.

2. EXPERIMENTS

Experiments may be devised to test the following properties on wood, plastics, metals, and laminates:

a. elastic range
b. plastic range
c. stress/strain ratios and curves
d. rupture point

C. OBSERVATIONS AND CONCLUSIONS

1. QUESTIONS TO BE ANSWERED DURING THE EXPERIMENTS

a. What is the difference between the stages of elastic and plastic?
b. Where do we use torsion in materials?
c. What is the difference between torsion and elasticity?
d. How does one find the modulus of elasticity?
e. At what point does the material rupture?

2. AREAS FOR FURTHER STUDY

a. Students may plot stress and strain curves for different materials, different diameter material, and different lengths of material. These curves should indicate the effect of cross-sectional area on the resistance to torsion.

V DEFINITION OF TERMS

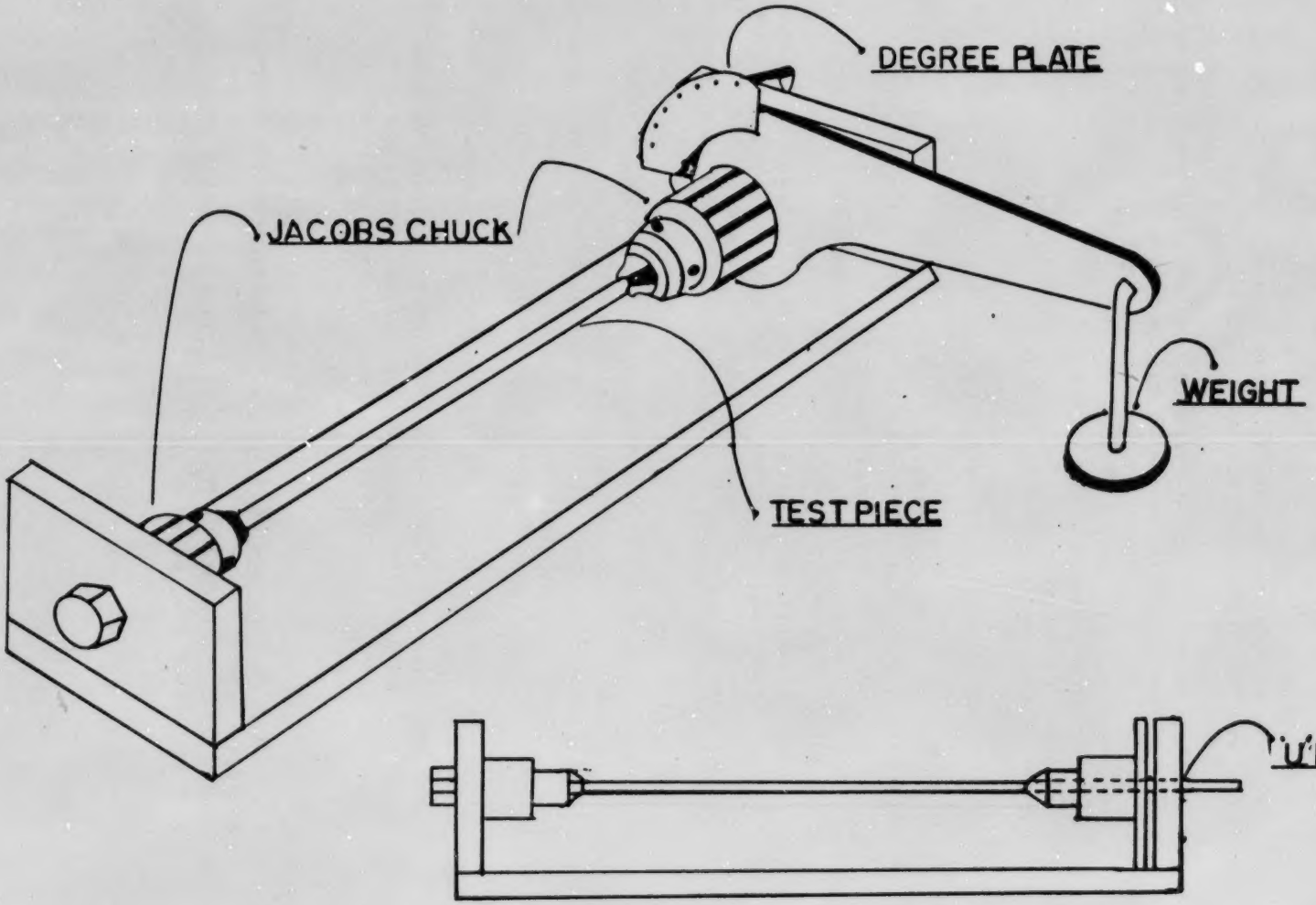
A. Ductility - the plasticity exhibited by a metal under tension loading; the metal is permanently deformed.
B. Elastic limit - maximum stress to which a metal can be subjected without permanent deformation.
C. Stress - Load per unit of area which tends to deform a body or a substance.
D. Strain - Deformation in units per unit of length produced in a body by stress.
E. Toughness - the property of absorbing energy before fracture.
F. Torsion - the act of turning or twisting one end or part of a length of material along its longitudinal axis, while the other end is held fast or turned in the opposite direction.

VI REFERENCES

Umoski, Joseph S., Ferrous Metallurgy, Chicago: American Technical Society 1960.

Van Vlack, L. H., Elements of Materials Science, Reading, Mass.: Addison-Wesley Pub. Co., Inc., 1966.

TORSION TESTER



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E.J.P

ACTIVITY REPORT

TITLE: Construction of a Multiple use Testing Device

PROCESSES: Testing by compression and expansion of numerous materials

MATERIALS USED: 3" x 3" x 3/16 square steel tubing 26" long, 2 pieces steel plate 6" x 12" x 1/4", 6" machinist vise, 250 lb. capacity Hansen spring balance, 1 piece 3/4"x 1 1/2"x 24" flat bar, 2 - 1/2 x 13 N.C. carriage bolts, 6" long. 1 piece 1/2" diameter x 5" C.R.S. 1 - 5/16" turnbuckle, holding clamps.

OBJECTIVES: To test a variety of materials and fasteners. The testing device may be used to test the breaking point and bending point, tensile strength, and holding power of many different holding devices.

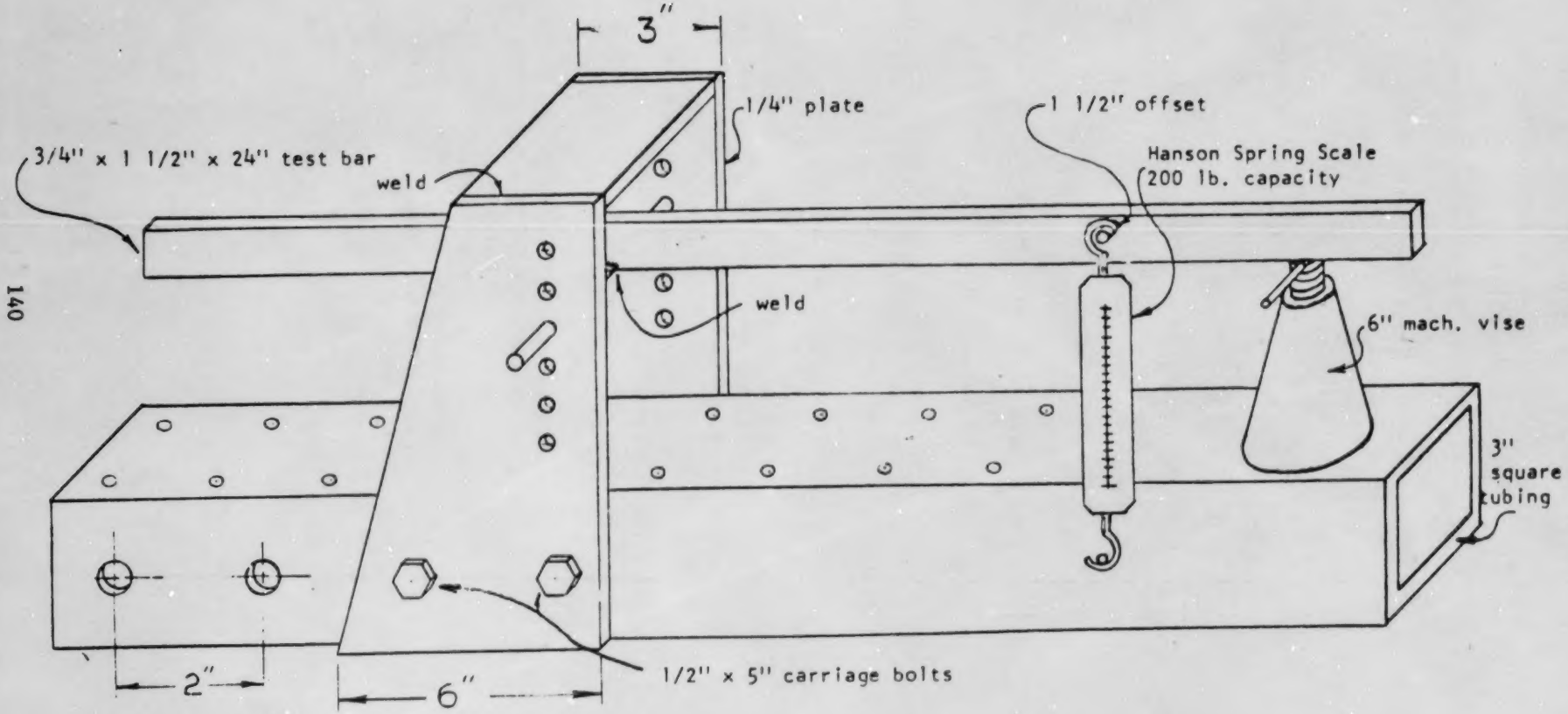
EQUIPMENT AND SUPPLIES: Power hack saw, metal cutting band saw, tap and die set, drills, drill press, welder, grinder, files, nuts and bolts, ball peen hammer, center punch.

REFERENCES USED: Arthur W. Earl, Experiments With Materials And Products of Industry. Bloomington, Ill.: McKnight Publishing Co., 1960.

PROCEDURES: As shown in the attached drawing lay out, center punch, and drill holes to mount 1/4" side plates. Lay out, center punch, drill and tap holes on top, 1" on center. Fabricate and weld fulcrum pin to the test bar. A Hanson spring expansion type scale or a regular bathroom scale may be used to take readings. A 6" machinists vise is placed between the test arm and the 3" square tubing base. Fabricate the necessary clamping devices for the materials or items being tested.

OBSERVATIONS AND CONCLUSIONS: It would be practically impossible to list all of the tests which could be performed. A few which can be performed are: the holding power of wood joints, solder joints, nails, screws, bolts, glues, rivets, the breaking point of plastics, wood, micas, welds and wire, the bending points of metals, the tensile strength of specimen pieces, etc.

MULTIPLE USE TESTING DEVICE



NOT TO SCALE

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STRUCTURES

Stand a 3 x 5 card on one of its longer edges and make it support a book.

What did you do to the card to succeed?

How heavy a weight can you support on the longer edge of an 8½ x 11 piece of notebook paper? (Without adding other materials to the paper.)

Sketch your design

Record your results as weight in grams...

Do you think a bigger or thicker piece of paper would support more weight?

Prove yourself right or wrong.

Try the same thing with a piece of aluminum foil.

In this case, which would you call "stronger," the foil or the paper?

TITLE: THE PRODUCTION OF NYLON 6/6 AND A CLASSROOM DEMONSTRATION

I INTRODUCTION

Nylon is one of the most widely used plastics which are a part of our everyday life. Clothing, bearings for childrens' toys, and reinforcement thread for automobile tires are a few of its uses. The methods used in production of nylon in the industrial situation are complex and complicated. This demonstration is a simplified version of the industrial application.

II OBJECTIVES

To enable the student to describe the production of plastics from raw materials.

III MATERIALS AND EQUIPMENT

4.4 grams of 1,6 - hexanediamine
50 mills of H_2O
2 mills of sebacoyl chloride
100 mills of carbon tetrachloride
1-500 cc beaker
an overhead projector and screen
1 pr. tongs
8" piece of ½" dowel

IV UTILIZATION IN THE TEACHING-LEARNING ENVIRONMENT

A. SAFETY
1. Safety glasses required.
2. Mix chemicals in a well ventilated area. The carbon tetrachloride produces lethal fumes. The sebacoyl chloride is also injurious to breathe.
3. Bring into classroom ready mixed, due to the semi-dangerous nature of materials during mixing stage.

B. PRESENTATION
1. Mix the sebacoyl chloride and the carbon tetrachloride and put in a 500 cc beaker.
2. Do not put the other chemicals into the beaker until mixed in a separate container.
3. Pour the 1,6 - hexanediamine and water slowly into the beaker of sebacoyl and carbon tetrachloride.
4. These will form two layers of liquids with a membrane in between.
5. Place the beaker on the overhead projector and project.
6. With a pair of tongs, reach into the beaker and pull up the membrane in the center.
7. The membrane will become visible as it is pulled away from the beaker walls.
8. A strand of nylon will be drawn from the membrane.
9. Place the strand of nylon on a piece of dowel and rotate.
10. The strand continues to be drawn as long as the two solutions unite to form the strand.

C. OBSERVATIONS AND CONCLUSIONS
1. QUESTIONS TO BE ANSWERED DURING THE EXPERIMENT
a. What is the name of the type of nylon produced?
b. Which solution has the lowest specific gravity?

c. Why does the membrane form?
d. Is nylon always produced in the form of a strand?
e. Why is carbon tetrachloride dangerous?
f. What are some of the different types of nylon?

2. AREAS FOR FURTHER STUDY
a. What are the physical properties of nylon?
b. What are the fabricating properties of nylon?
c. What properties does nylon possess that are not beneficial to industrial and commercial applications?

V. DEFINITION OF TERMS

A. Specific gravity - the ratio of a mass of a body to the mass of an equal volume of water at 4 degrees C or other specific temperature.
B. Solution - a mixture-- liquid, solid, or gaseous,--in which the components are uniformly distributed throughout the mixture.
C. Membrane - a thin, soft, pliable sheet or layer, especially of animal or vegetable tissue, serving as a covering or lining.
D. Plastic - any of various nonmetallic compounds, synthetically produced, which can be molded into various forms and hardened for commercial use.
E. Drawn - to take out, disemboweled from.
F. Nylon - a highly elastic, very strong, synthetic material derived from coal, water, and air, and made into thread, bristles, sheets and molding material.
G. Carbon tetrachloride - a noninflammable, colorless liquid, used in fire extinguishers, as a solvent for fats, and as an industrial chemical.

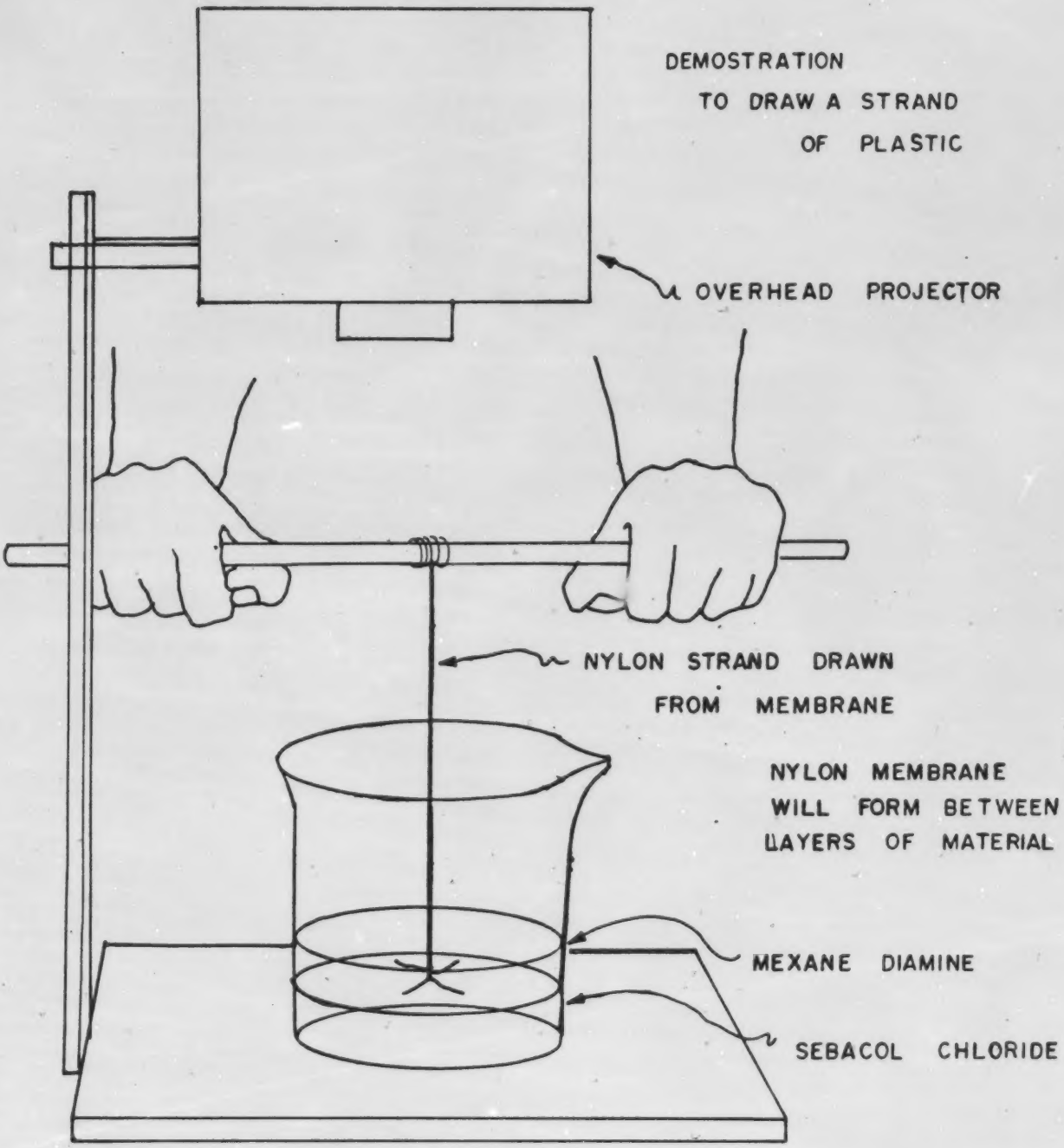
VI REFERENCES

Clauser, H. R. (Ed), The Encyclopedia of Engineering Materials and Processes, New York: Reinhold Pub. Corp., 1963. page 450-492.

Plastics Engineering Handbook (3rd Ed). New York: Reinhold Pub. Corp ., 1962, page 87-90.

Modern Plastics Encyclopedia, Vol. 43, McGraw-Hill Pub., Book No. IA, September, 1965. page 197-202.

A CLASSROOM DEMOSTRATION OF THE PRODUCTION OF NYLON 6/6



D.L.L.

Title of Activity: How to distinguish between hardwood and softwood.

Processes Involved: Gluing

Object of Activity: To show how the cell structure of hardwood and softwood differ.

Materials Needed:
Plastic drinking straws
(two different size diameter straws)
White vinyl glue
Rubber bands
Shellac or dark paint

References Used:
School Shop, May, 1972
John L. Feirer, Woodworking for Industry. Peoria Illinois: Charles A. Bennett, Inc., 1971.
See Resources and Supporting Media section: P-16.

Procedure for Activity:

A. Hold straws together, with rubber bands.
B. Glue large diameter straws together.
C. Section off small diameter straws into four sections.
D. Place brown paper in sections (represents latewood tracheid fibers).
E. Glue small diameter straws together.
F. Pour shellac or dark paint into large straws. This is to represent the latewood tracheids, resin ducts, and border pits.

Observations and Conclusions:

A. The brown paper did not differentiate very well between latewood and tracheid fibers. A heavier paper would be more satisfactory.
B. Pour only a small amount of shellac into the straw openings. A restriction (glue) should be used to prevent the shellac from flowing completely through the straws.
C. The large straws represent cells of softwood. The small straws represent hardwood cells.
D. Paper straws should be used. White glue will work better when using paper straws.

TITLE: HARDNESS OF DIFFERENT SPECIES OF WOODS

I INTRODUCTION

Woods that are to be used where there is likely to be heavy penetrating forces such as floors and counter tops should be selected for their relative hardness and wear resistance as major factors. It is for this reason that an understanding of the hardness of woods is necessary to select woods to be used under heavy wear and penetrating stresses.

II OBJECTIVES

A. To show that there are differences in the hardness of woods of different species.
B. To show that there are differences in the hardness of the face grain, end grain, and edge grain.
C. Moisture content of woods has a definite effect on hardness.

III MATERIALS AND EQUIPMENT

A. Test samples of different species of woods. Samples should have distinct edge and face grain and be 1½" x 1½" x 1½".
B. Testing frame as illustrated
C. Torque wrench
D. Laboratory balance
E. Drying oven or heat lamp & 5 gallon can.

IV UTILIZATION IN THE TEACHING-LEARNING ENVIRONMENT

A. SAFETY

Be sure that the test device is securely fastened down to prevent slipping as pressure is applied.

B. TEACHING METHOD

1. LECTURE DEMONSTRATION
   a. Present end view of wood grain showing cell wall size showing that the thicker walled cells when dried present a denser mass than does thin walled cells.
   b. Discuss the relationship of growth ring population to the hardness of the various species of wood.
2. EXPERIMENTS
   a. Test samples are taken at equilibrium and placed in the test device and the ball torqued down until it penetrates the surface to ½ its diameter.
   b. Make at least 2 tests on each surface (edge, end, and face grain)
   c. Record the ft. pounds required for each test. (see sample chart at the end of the unit.)
   d. Samples may then be oven dried, weighed, and then soaked in water for several days completely submerged.
   e. Make a chart showing the averages for each test.
   f. Tests should be run again on each piece weighing it each day and recording torque and weight.

g. Record the moisture content for each test and prepare a graph showing relationship of moisture content to hardness.

$$\% \text{ moisture} = \frac{\text{test weight - oven dry wt. x 100}}{\text{oven dried weight}}$$

C. OBSERVATIONS AND CONCLUSIONS

1. QUESTIONS TO BE ANSWERED DURING EXPERIMENTS
   a. What affects have moisture content on the hardness of woods.
   b. Which woods are harder than others.
   c. Are woods classified as hardwoods always harder than softwoods.
2. AREAS FOR FURTHER STUDY
   a. Conduct similar dry test on other wood products. Masonite, particle board, etc.
   b. Tests compared to density of woods or specific gravity.

V DEFINITION OF TERMS

A. Hardness: The resistance of woods to wearing and marring. It is measured by the load it will take to force .444" ball into the sample to one half its diameter.

B. Equilibrium: When the moisture content of the wood has stabilized with the humidity of the area.

VI REFERENCES

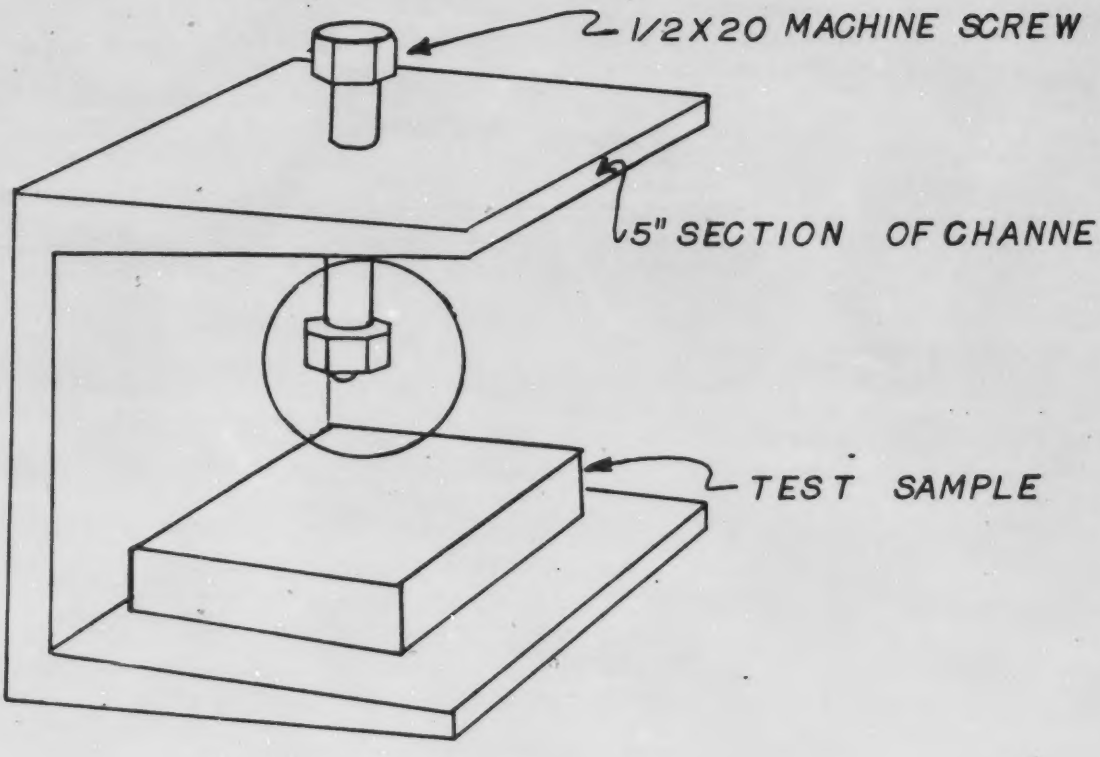
Wood Handbook #72, Forest Products Laboratory, U.S. Government Printing Office, Washington, D.C., 1955, p. 69.

ASTM Standards Part 6, 1958, pp 92-93.

RELATIVE HARDNESS
(JANKA BALL)

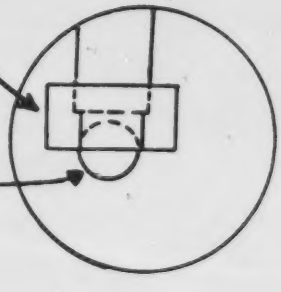
SELECTED SPECIES	WET (112% to 50%) END	WET (112% to 50%) SIDE	DRY (12%) END	DRY (12%) SIDE
1. Alder, red	550#	440#	980	590
2. Ash, white	1010#	960#	1720	1320
3. Birch, yellow	818#	780#	1480	1260
4. Cherry, black	750	660	1470	950
5. Maple, big leaf	760	620	1330	850
6. Oak, red	1060	1000	1580	1290
7. Oak, white	1120	1060	1520	1360
8. Walnut, black	960	900	1050	1010
9. Douglas Fir	570	500	900	710
10. Pine, white	300	290	480	380
11. Redwood	570	410	790	480
12. Spruce, sitka	430	350	760	510

MODIFIED JANKA BALL TEST



1/2X20 NUT SOLDERED SO THAT 1/2 OF THE BALL IS EXPOSED.

1/2 STEEL BALL



TITLE: BENDING STRENGTH OF WOODS

I INTRODUCTION

Lumber which is used in various structural assemblies is subjected to many different stresses among which are those introduced by the different affects of cantilever. Resistance to deflection under such stresses is subject to the variables which affect the physical characteristics of the wood, such as moisture content, relationship of the annular rings to the direction of stressing, specific gravity, annular ring population, and the length of the wood fibers. It is important to show that these forces do exist and that in the design of various structures it is important to understand the degree to which they affect the load carrying capacity and deflection characteristics of the wood.

II OBJECTIVES

A. To show the relationship of deflection to the direction of growth rings and the direction of force.
B. To show that moisture content has a decided affect on the strength of the wood.
C. To show that the percent of late growth to early growth has an affect on the stiffness and strength of wood.
D. To show the strength advantages of laminated beams over solid beams.

III MATERIALS AND EQUIPMENT

A. Test samples
   1. Clear, straight samples of several common woods that are 1" x 1" x 24".
   2. Laminated samples of the same woods that have the same dimensions.
B. Test device (see attached sketch #1)
C. Laboratory Balance
D. Drying oven

IV UTILIZATION IN THE TEACHING-LEARNING ENVIRONMENT

A. SAFETY

Be sure that the samples being dried are not placed too close to the heat source or are dried at too high a temperature (wood combusts over 525 degrees F.)

B. PRESENTATION
   1. LECTURE-DEMONSTRATION
      discuss the following:
      a. Fiber saturation of wood and hardening and stiffening affect the removal of moisture has on the fibers of wood.
      b. Seasoning-degrade and the affects it has on strength.
      c. Specific gravity and explain why this might have an affect in the strength of the wood.
      d. Annular ring placement affect on the load carrying capacity of the wood.
   2. EXPERIMENT
      a. Place the samples in the holding clamp and suspend the weight from the end, record deflection.
      b. Make several tests with each sample with the growth rings in different position to the direction of force.

c. Dry the samples in an oven until they stop losing weight and record results. (dry slowly at about 125 degrees F)
d. Soak samples in water for one week, weigh, compute moisture content and repeat the test.
e. Dry overnight and weigh, compute moisture content and retest.
f. Continue the tests until the samples reach equilibrium.
g. Determine the specific gravity and repeat the test.

C. OBSERVATIONS AND CONCLUSIONS
1. QUESTIONS TO BE ANSWERED DURING EXPERIMENTS
a. What are the affects of moisture content on the strength of the wood?
b. What affect does specific gravity have on bending strength?
c. Does placement of growth rings with regard to the direction of force have an affect on strength?
2. AREAS FOR FURTHER STUDY
a. Test the samples suspended between two points and the weight in the center and see if similar deflections occur.
b. Raise the temperature of the samples to see if elevated temperatures affect the strength characteristics.
c. Test the samples under prolonged load to see if there is more if the wood is loaded when wet than when dry.

V DEFINITION OF TERMS

A. Fiber Saturation Point - the point which is approximately 30% for all species, when all the free moisture is gone from the wood. (see attached sketches #2 and #3)

B. Seasoning Degrade - defects of wood which occur during and are caused by seasoning. Those defects which affect strength are of particular concern here as in the case of surface and end checking.

C. Moisture content - percent of water to wood, computed as follows:

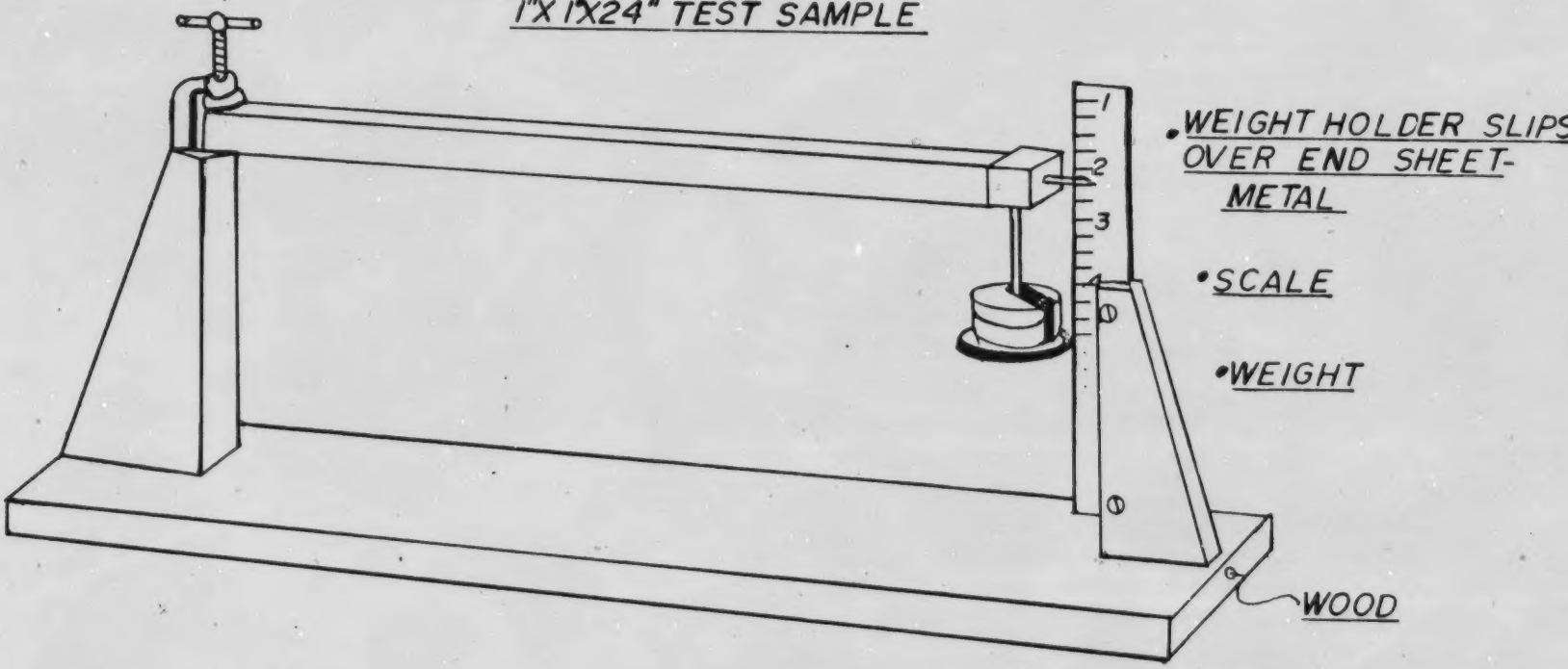
$$\% \text{ moisture content} = \frac{\text{wet weight} - \text{oven dried weight} \times 100}{\text{oven dried weight}}$$

D. Equilibrium - When the moisture content of the wood stabilizes with the moisture content of the atmosphere.

VI REFERENCES

Fairer, John L., Woodworking for Industry; Peoria, Ill: Charles A. Bennet Co., Inc., 1963. pp 103 - 110
Wood Handbook #72, Forest Products Lab., Washington, D.C.: USGPO.
ASTM Standards, Part 6, 1958. p 680, 736

BENDING STRENGTH OF WOOD



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C.K.

TITLE: JOINT TESTER

I INTRODUCTION

A manufacturers choice of wood joints to be used in a particular construction problem is of importance because of strength and appearance. If the wrong joint is selected, it will not perform its function. The manufacturer will possibly suffer a monetary loss, as well as, a loss of prestige.

II OBJECTIVES

A. To show the strength of wood joints.
B. To show fracture points of a variety of wood joints.

III MATERIALS AND EQUIPMENT

The material used for the construction of this equipment is hardwood. This device is used to test the holding capabilities of various joints and an average reading compiled from the data gathered.

IV UTILIZATION IN THE TEACHING-LEARNING ENVIRONMENT

A. SAFETY
   1. Do not place hands under joint to be tested.
   2. Clamp test device securely to work bench.
B. PRESENTATION
   1. teacher demonstration
   2. student experiment

   For a teacher demonstration, a variety of sample joints would have to be constructed beforehand. In order to operate this unit, a sample joint is placed in the hold down device. A hole has to be drilled in the joint in order for the bolt to protrude (see sketch). A torque wrench is used to apply pressure to the joint. The use of a torque wrench enables one to make a comparative test in relationship of one joint to another. When testing a particular joint, a number of tests should be performed on the same type of joint.
C. OBSERVATIONS AND CONCLUSIONS
   1. QUESTIONS TO BE ANSWERED DURING THE EXPERIMENT
      a. What type of joints hold more satisfactorily?
      b. At what stress points do various joints fracture?
   2. AREAS FOR FURTHER STUDY
      a. Why is one joint used instead of another?
      b. How are joints constructed?
      c. What types of joints are used more in mass production?

V DEFINITION OF TERMS

A. Wood Joint - the junction of two pieces of wood or veneer.
B. Adhesive - a substance capable of holding materials together by surface attachment.
C. Bond - the attachment at an interface between an adhesive and an adherent.

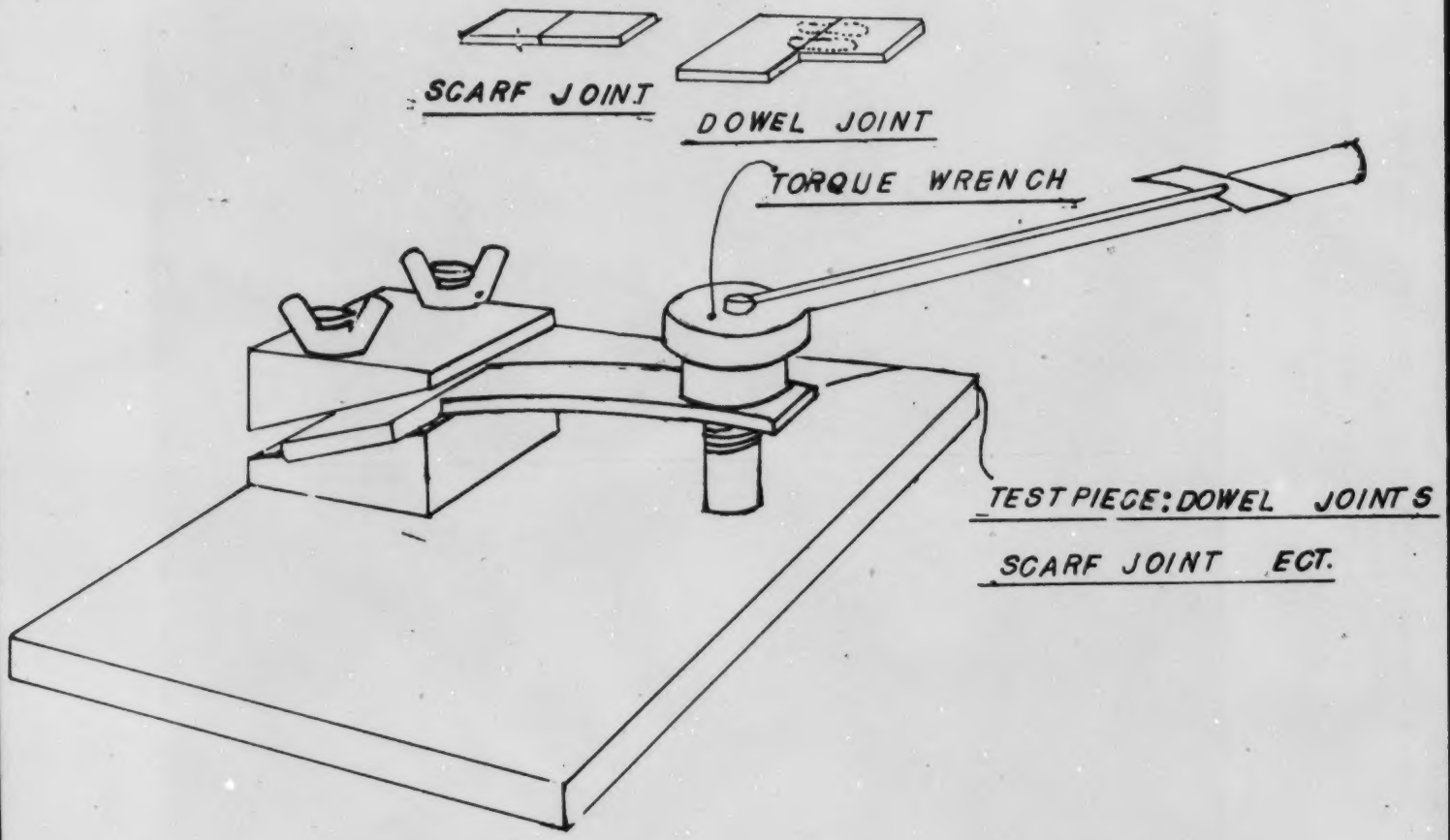
VI REFERENCES

Hammond, James, Woodworking Technology, Bloomington, Illinois: McKnight & McKnight, 1966.

Hayward, J. Woodwork Joints, New York, J. B. Lippincott Co., 1950.

A.S.T.M. Standards, Part 6, American Society for Testing Materials, Philadelphia, Pennsylvania, 1958.

JOINT TESTER



BY: K-P

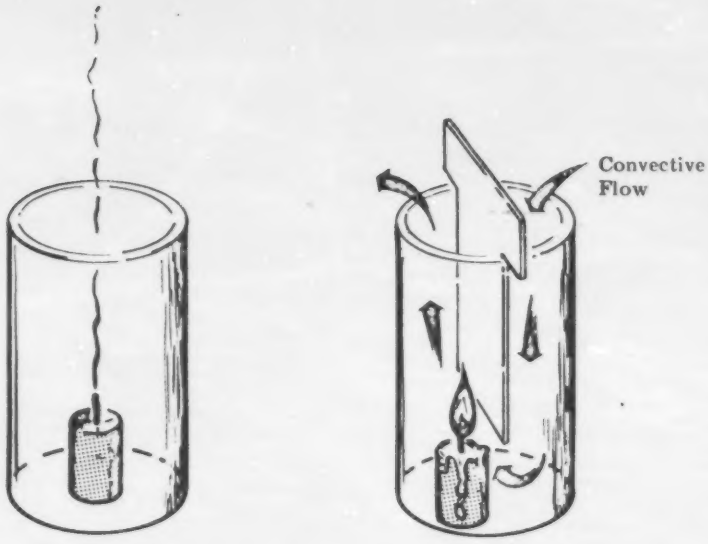
SKYLAB EXPERIMENTS

The following activities are classroom demonstrations related to NASA's Skylab experiments. The Skylab served to allow scientific investigation of the possibilities for processing materials in the weightless environment of space. The results of the Skylab project provided knowledge for space processing facilities that began with the Space Shuttle program. The complete write up is entitled Skylab Experiments: Vol. 3, Materials Science, Washington, D.C.: NASA, May, 1973. Contact the Educational Programs Officer, NASA, Langley Research Center, Hampton, Virginia, 23665, to request a copy.

- Look closely at a piece of galvanized steel. Note the fan-like groupings of zinc crystals covering the surface. These are grains of zinc crystals overlapping each other.

Convection

- The role of convection in combustion is easily demonstrated by placing a candle at the base of a container, such as the chimney of a kerosene lamp. The base of this chimney is closed and the top is open. Note how long the candle continues to burn. Now suspend a T-shaped piece of material reaching almost down to the flame and slightly offset. The air mass begins a convective flow down one side of the divider and up the other side.



Convection in Combustion

Finally remove and store the experiment specimens and apparatus and clean the work areas in preparation for the next experiment.

DATA

Information resulting from these experiments will be derived from postmission analysis of telemetered data and returned specimens formed.

Photographic data of those activities suitably exposed will also be available. The specific data generated by each experiment will be discussed in that experiment description. Generally this data and the results of specimen analyses are expected to be available between 90 days and a year after performance of the experiment.

RELATED CLASSROOM DEMONSTRATIONS

Water may be used to demonstrate some of the solidification processes of metals.

Crystal Growth

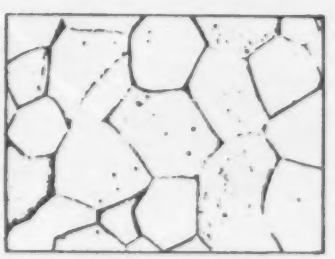
- Nucleation and crystal growth can be demonstrated with water by lowering the temperature of pure water below its freezing point. Foreign objects of small radii should not be present in the water, and it is sometimes necessary to wax the container. At a temperature of about -4° or lower, drop a small ice crystal into the undercooled water and it will freeze immediately. The ice crystal acted as a nucleation site.

Dendrite Growth

- Dendritic growth of ice crystals can be observed by lowering the temperature of a glass plate to below the freezing point of water (i.e., by chilling the plate in the freezer section of the refrigerator), and maintaining that temperature while allowing cool water vapor to condense on the plate. This produces frost patterns that are characteristic of dendritic growth. (See illustration.)

Dendrite growth of water crystals

- The grain boundaries of a piece of metal are normally invisible. A metallographic technique to observe a metal specimen is to etch the grains to make them visible. The metal specimen may be prepared by highly polishing and etching it with a dilute etchant and washing it with alcohol and water. The specimen may then be observed using a microscope with low angle illumination. (It may require a second polishing and etching to produce a useful sample, as illustrated.) The etching fluids are usually dilute (2-4%) alcholic solutions of acids or bases. Examples include:
  - steel, 2% nitric acid in alcohol or 4% picric acid in alcohol;
  - gold and platinum, aqua regia;



Microscopic view of grain boundaries made visible by chemical etching

known quantity of radioactive iodine at one end. Periodically remove the cover and sample a small amount of the solution at incremental distances from the end. Repeat the experiment with vertical tubes of the solution and add the radioactive iodine to the top of the tubes. Check for diffusion downward.

LIQUID METAL IN FREE FALL

The shape of metal in a weightless environment can be demonstrated by allowing liquid lead or tin to fall some distance (over 3 meters) into a tank of water. Melt some lead or tin and carefully pour the liquid over a heated steel screen. The molten metal will pass through the screen and drops will fall into the water. (See Figure 2-14.) The metal will freeze quickly thereby retaining most of the free-fall shape.

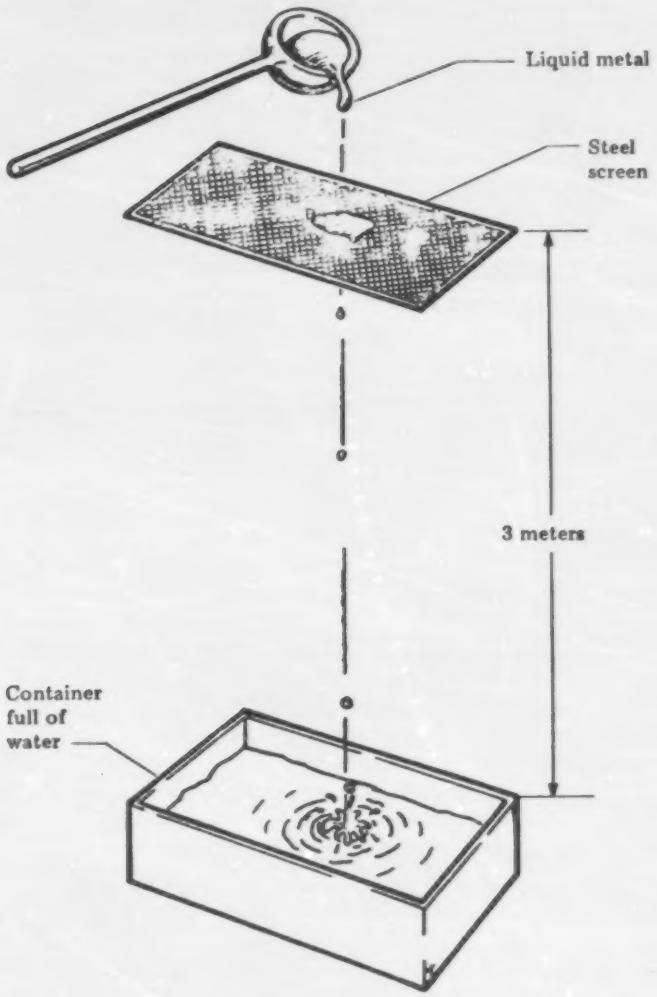


Figure 2-14 Demonstration of Liquid Metal in Free Fall

Sphere forming experiment

Wide Range of Drop Shapes

The solidified drops of metal may have other than spherical shapes because of various stresses that exist in the experiment. The liquid metal may develop oscillations resulting from the stretching and release of the droplet. Also, the drag forces of the fall through air will tend to flatten the drop. Try dropping the liquid metal from varying heights up to several feet and note the variations in drop shape for the different increments in drop height.

CAUTION Adequate safety precautions should be applied to avoid burns.

CRYSTALS OF SODIUM BROMATE

Dissolve a saturated solution of sodium bromate in water and allow the liquid to cool. Saturate a string with sodium bromate crystals and allow to dry. Suspend the string in the solution and place the apparatus in a refrigerator. Cool the solution to about 10 to 20°C for three or four days. Crystals of sodium bromate will attach and grow seed crystals on the string.

TITLE: POWDER METALLURGY

I INTRODUCTION

Modern industry is presently making extensive use of powdered metal in its production of small prefinished metal parts. Examples of such parts are small gears, oil impregnated bearings for electrical motors, fuel line filters, tungsten carbide cutting tools, model parts such as the wheels for model trains, to name but a few. These parts require little if any finishing after production. This demonstration will show how powdered metal is converted into different forms. The method used is not a production method but is similar in technique.

II OBJECTIVES

To demonstrate the concept of compressing metal powders, under high pressure, into items that may be mass produced in production processes.

To show composition of un-sintered metal briquettes made from powdered metal.

III MATERIALS AND EQUIPMENT

Hydraulic press: (see attached sheet for details)
Briquette die and mold: (see attached sheets)
Measuring device: measuring in grams or a measuring spoon capable of measuring a level teaspoon of powdered metal.
Powdered graphite
Small brush: small enough to be inserted in mold
Samples of powdered metal: Iron, Brass, Copper, Aluminum, Tin and Lead
Powdered metal may be obtained from:

The Gidden Company
Metals Division
Post Office Box 217
Johnstown, Pennsylvania 15907

IV UTILIZATION IN THE TEACHING-LEARNING ENVIRONMENT

A. SAFETY

Place briquette die and mold in the center of platen on the press so platens of press will not be damaged and die will not have a tendency to shoot out of press.
Build pressure slowly so an even pressure will be placed on die and materials without causing an undue strain.
RELEASE PRESSURE SLOWLY as releasing pressure too rapidly may turn die and mold into a missile allowing it to shoot through the air.

B. PRESENTATION

Using a commercial hydraulic press and briquette die and mold or the shop constructed hydraulic press and briquette mold and die (see attached sheets) set up demonstration materials and equipment.
Lubricate the briquette mold with powdered graphite to prevent

adhesion to the mold walls. With the lower die punch inserted, measure 70 grams or 1 level teaspoon of powdered metal into the mold. Tap mold to level particle distribution. Insert upper die, punch and place in the CENTER of the platens of the press. Apply briquette pressure of 20,000 psi. Release pressure of press SLOWLY. Remove lower die punch and repress to demonstrate proper method of ejecting briquette from mold.

C. OBSERVATIONS AND CONCLUSIONS

1. QUESTIONS TO BE ANSWERED DURING EXPERIMENT
   What effect will high pressure have on the powdered metal?
   Will all of the powdered metal placed in the mold be compacted into the briquette?
   Would the diameter of the die punch have any effect on the amount of pressure required to make the briquette?
2. AREAS FOR FURTHER STUDY
   Study the brittleness and hardness of different metals that have been subjected to the same amount of pressure.
   Study the effect of sintering the briquette to obtain a harder or malleable material.

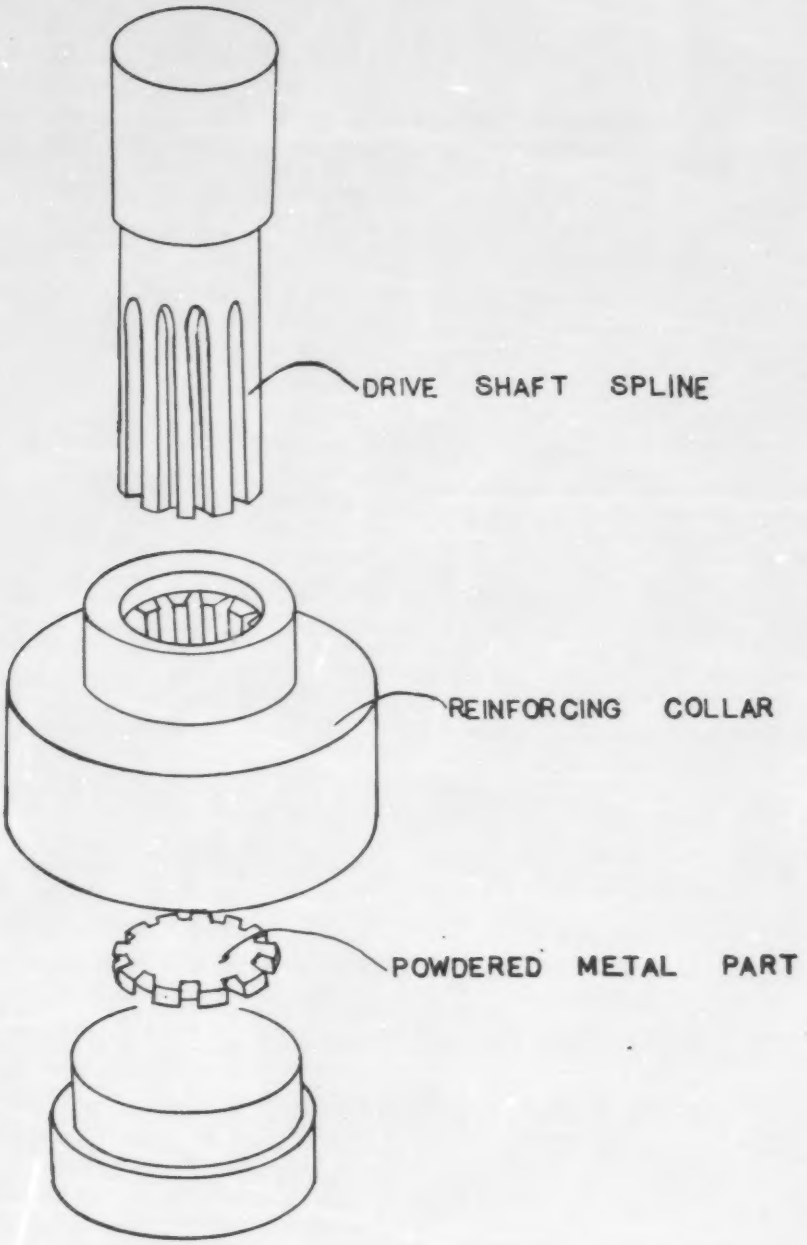
V DEFINITION OF TERMS

ADHESION: Metal clinging to side or attaching itself to side of walls of mold.
BRIQUETTE: small tablet of material obtained after being compressed.
DIE: metal stamp used in compressing powdered metal within the mold cavity.
GREEN: soft, not sintered
IMPREGNATED: saturate throughout the material.
MALLEABLE: having the ability to be shaped or formed by hammering or rolling.
MOLD: form in which metal is compressed by die punch.
PLATEN: bed of press; top and bottom plates
PSI: pounds per square inch
SINTERED: heating of briquette in oxygen free furnace to cause changes in spaces between crystals of the metal.

VI REFERENCES

A.S.T.M. 1961, Part No. 3; Page 1035 "Compressability of Metal Powders."
Powdered Metallurgy Equipment Manual, Powder Metallurgy Equipment Association, 60 E. 42nd Street, New York, New York.

POWDER METALLURGY



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TITLE: HAMMER DIE FOR POWDER METALLURGY

I INTRODUCTION

Many of the small metal items in use today originated from powdered metal. A good example of this are the wheels on Lionel electric trains. Various types of metal are ground very finely and then compressed into the desired shape under approximately 20,000 pounds pressure. The powder metallurgy industry is growing daily, thus, providing many new jobs.

II OBJECTIVES

A. To demonstrate the process of powder metallurgy without the aid of a hydraulic press.
B. To stimulate interest on the part of the student for further study of powder metallurgy.

III MATERIALS AND EQUIPMENT

A. A die with a 3/8" diameter hole to receive the powdered metal.
B. Powdered metal of various kinds, such as copper, brass or iron. Use about 1/8 teaspoon for each briquette.
C. A medium size hammer.
D. A furnace capable of maintaining temperatures up to 1500 degrees for one hour.

IV UTILIZATION IN THE TEACHING-LEARNING ENVIRONMENT

A. SAFETY
   1. Proper eye protection should be used when hammering the die to compress the powdered metal.
   2. Use care with the oven when inserting and removing briquettes.
B. PRESENTATION
   1. LECTURE DEMONSTRATION
      a. Present lecture on powder metallurgy pertaining to its use in industry.
      b. Demonstrate the process by using the hammered die.
      c. Sinter the briquette in a furnace at a temperature of 1500 degrees for one hour. Place a piece of charcoal in the furnace to help control the atmosphere in the furnace.
      d. After the briquette has cooled, place it back in the die for an additional blow with the hammer. This is called coining.
      e. File the briquette to see how hard it is.
      f. Drill a hole in the briquette.
C. OBSERVATIONS AND CONCLUSIONS
   1. QUESTIONS TO BE ANSWERED DURING THE EXPERIMENTS
      a. What holds the powdered metal together after it is pressed in the die?
      b. Is the briquette as hard as it would be if pressed by a hydraulic press?

c. Is a briquette harder before or after cooling?
d. What are some of the products that are made by this process in industry? Why?

2. AREAS FOR FURTHER STUDY
   a. Study other materials that may be allowed to form a briquette.
   b. Study the various tests that are performed on powder metallurgy specimens.

V DEFINITION OF TERMS

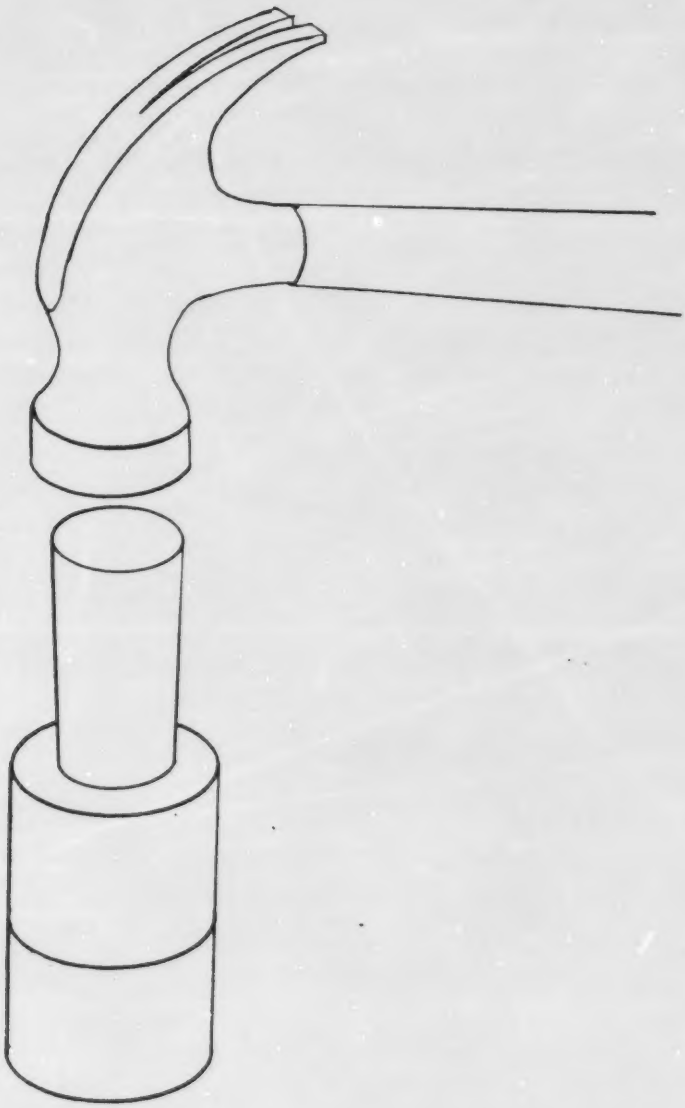
A. Powder metallurgy - is the technology of transforming metal powdered into finished or semifinished products by mechanical and thermal operations.

B. Coining - is the process of repressing the briquette after sintering to make it stronger.

VI REFERENCES

Metal Science Book Lab, "Discoveries in the Science of Metals," New York: Science Materials Center, Inc., 220 E. 23rd St.

Fundamental Principles of Powder Metallurgy, W.D. Jones; London: Edward Arnold Publishers, Ltd. 1960.



TITLE: PARTICLE BOARD FORMATION

I INTRODUCTION

A building particle board is a sheet material manufactured of refined or partially refined wood. Binding agents and other materials may be added during manufacture to increase strength, resistance to moisture, fire, or decay or to improve some other property. Among the materials added are rosin, alum, asphalt, paraffin, various cements, preservative and fire resistant chemicals, synthetic resin, and drying oils. The resin-bonded particle boards are made by blending wood particles or chips with various resins and consolidating the mixture under heat and pressure. Production of resin-bonded particle boards is increasing, because more manufacturers are realizing that it is a profitable way to utilize residue from millwork, furniture manufacture, or similar operations.

II OBJECTIVES

1. To demonstrate in a simplified manner how particle board and resin-bonded particle board are manufactured.
2. To show the effects of moisture on particle board and resin-bonded particle board.

III MATERIALS AND EQUIPMENT

Commercially made hydraulic press or shop constructed hydraulic press.
Platens with heat elements capable of 300 degrees F.

Supply of wood chips of various types of wood; approximately one cup of each type.
Mold and die punches - powdered metal mold and die punches may be used. Molds with larger diameter may also be used (see attached sheets).
Phenol resin or resorcinol glues.
Thermometer capable of registering temperatures up to approximately 350 degrees F.
Glass or beaker filled with water.

IV UTILIZATION IN THE TEACHING-LEARNING ENVIRONMENT

A. SAFETY
   1. Place mold and die punches in the center of the press platens to prevent damage to the platens or the possibility of the mold becoming a missile and shooting through the air.
   2. Release pressure from the die punches slowly to prevent the possibility of the die shooting through the air.
   3. In releasing pressure, watch for the possibility of entrapped air or steam escaping.

B. PRESENTATION
   1. LECTURE AND/OR DEMONSTRATION
      a. Without Resin
         Place lower die punch in mold and fill and pack the mold by hand with chips of wood. Place upper die punch in mold and place the dies and mold in the center of the lower platen of the hydraulic press. Raise the lower

platen until the upper die punch comes into contact with the upper platen of the press. Increase the pressure until a pressure of 10,000 psi. is reached. Release pressure slowly. Remove the lower die punch and eject the piece of particle board. Repeat the process with chips of different types of wood to produce particle boards with different grain structure.

b. With Resin

Preheat platens of the hydraulic press, and the mold and dies to the setting temperature of the glue being used. (Resorcinol glues require from 100 to 200 degrees F.; Phenol resin requires a temperature of 300 degrees F.) Place the lower die punch in the mold. Mix thoroughly the wood chips with the glue to be used. Fill and pack the mold, by hand, with the chips of wood and glue mixture. Place the upper die punch in mold and place dies and mold in center of lower platen of the hydraulic press. Raise the lower platen until the upper die comes in contact with the upper platen of the press. Increase the pressure of the press until a pressure of 10,000 psi. is reached. Retain this pressure on the press for a period of 15 minutes. Release the pressure slowly. Remove lower die punch and eject the piece of particle board. Repeating the process with chips of different types of wood will produce particle board samples with different grain structures.

2. EXPERIMENT

Immerse particle board samples in a glass of water to see what effect moisture has on the particle board. Test piece without resin-bonding material first and repeat with the resin-bonded piece.

C. OBSERVATION AND CONCLUSIONS

1. QUESTIONS TO BE ANSWERED DURING EXPERIMENTS
   a. Would particle board which is not resin-bonded be a proper material to use if it can be subjected to moisture?
   b. What effect did heat play in making the resin-bonded particle board?
2. AREAS FOR FURTHER STUDY
   a. Test the hardness and brittleness of the different particle boards made from different woods.
   b. Test for hardness and brittleness of particle boards with and without resin as a gluing agent.
   c. What industries utilize particle board?

V DEFINITION OF TERMS

A. Binding agent - material used to glue or hold wood particles and chips together.
B. Bonded - held together.
C. Die - metal stamp used to compress wood chips within mold cavity.
D. Mold - form in which metal is compressed by die punch.
E. Platen - bed of press; top and bottom plates.
F. Preservative - Substance effective in preventing action that will rot wood.
G. Residues - materials left over.

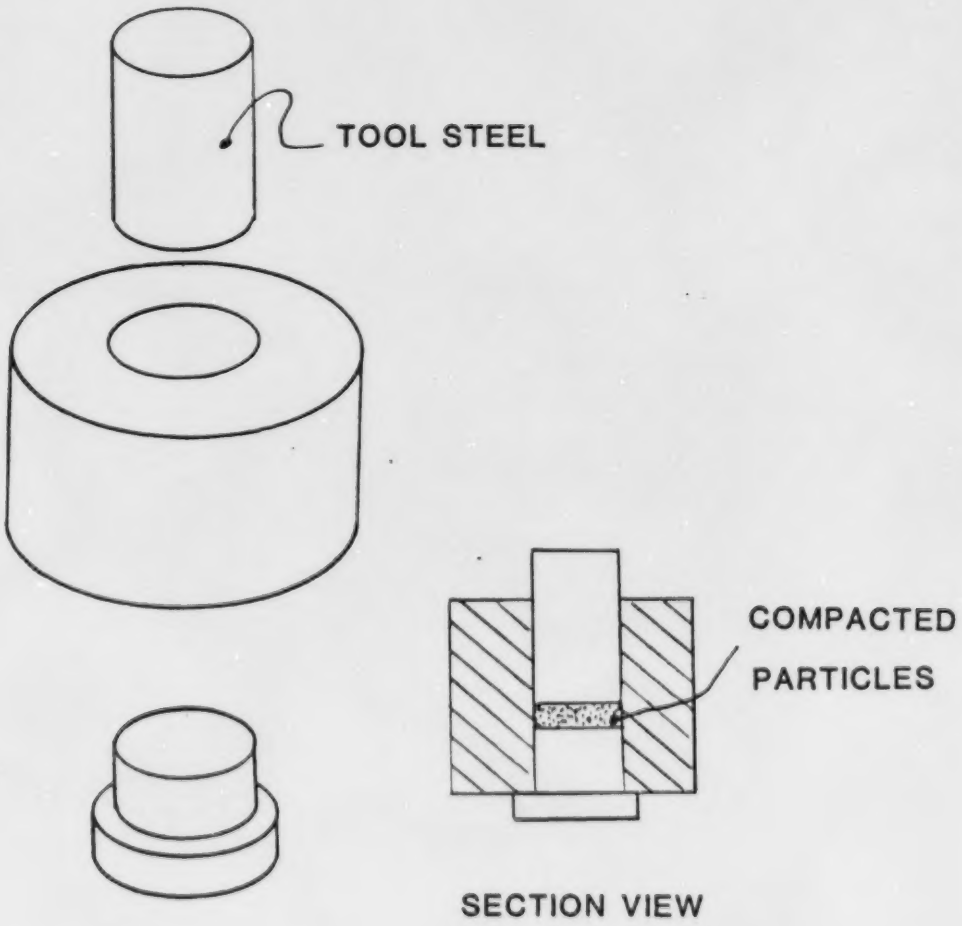
H. Resistant - to withstand or to slow down.
I. Synthetic resin - man made glue, not a gluing agent made by nature.

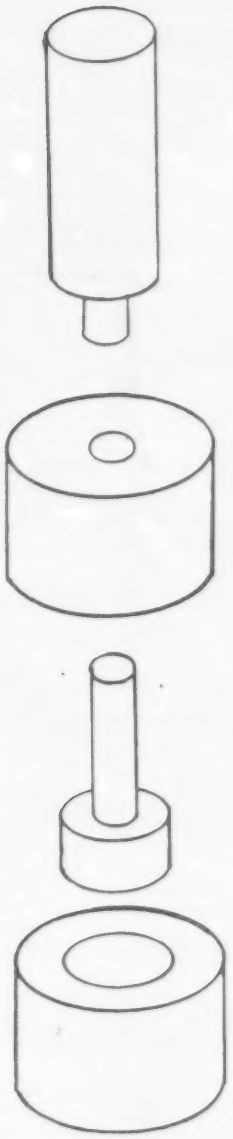
VI REFERENCES

Wood Handbook #72, U. S. Department of Agriculture, Forest Products Laboratory, Madison 5, Wisconsin, 1955, pp 236-237 and 457-465.

A.S.T.M., 1958, Part 6, pp 92-93, American Society for Testing Materials.

Hammond, James J., Woodworking Technology, McKnight & McKnight, Bloomington, Illinois, 1966.


TOOL STEEL
COMPACTED
PARTICLES
SECTION VIEW



ACTIVITY REPORT

TITLE OF ACTIVITY: Reinforcing Styrofoam

PROCESSES INVOLVED:
A. Joining process - adhesion
B. Forming
C. Machining
D. Finishing

MATERIALS INVOLVED:
A. Styrofoam
B. Flour paste
C. Newspaper
D. Fiberglass
E. Resin

OBJECT OF ACTIVITY: To demonstrate the use of fiberglass as a reinforcing agent.

MATERIALS NEEDED:
Styrofoam sheeting
Newspaper
Flour
Water
Fiberglass matt
Resin and hardner
Sand paper

EQUIPMENT NEEDED:
Mixing containers
Fiberglass working tools

REFERENCES USED: None

PROCEDURE FOR ACTIVITY:
A. Cut form and assemble styrofoam into desired object.
B. Mix flour and water to make thin paste.
C. Apply paste to object.
D. Apply newspaper to object (use at least three layers of paper and paste).
E. Allow paste to dry.
F. Cut fiberglass to desired size for object.
G. Mix resin and hardner and apply to object.
H. Apply fiberglass and roll to compact it. (Use as many layers as required for strength desired).
I. Trim edges and sand.
J. Finish as desired.

OBSERVATIONS AND CONCLUSIONS: This procedure can be used to reinforce any object constructed of styrofoam from ice chests to boats.

TECHNOVATE

MATERIALS TESTING

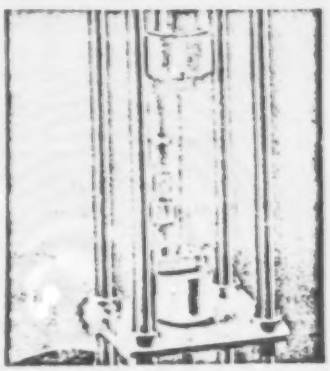
OBJECTIVE: Determine the tensile characteristics of 6061-T6 Aluminum Alloy.

PROCEDURE:

1. Set up the tensile specimen in the Materials Test Instrument as shown in the photograph.
2. Adjust the micrometer to read zero with no load on the specimen.
3. Apply the load by means of the hand pump until an elongation of .001 inch is read. Record the load.
4. Apply additional loads, recording the loads at elongation in increments of .0002, .0003, and .0004 inch.
5. Retract the micrometer and remove the load. Repeat steps 2, 3, and 4, twice.
6. Plot load vs. elongation. Is the plot a straight line? Explain. Determine the initial cross-sectional area and length of the specimen's test section. Calculate stress and strain and plot. Are the plots the same? Explain.

Set up for aluminum alloy tensile test

7. After removal of the load each time in Step 5, does zero elongation correspond to zero load? Explain.
8. Load the specimen up to an elongation of .004 inch. Increase the load in increments of .0005 inch elongation. Plot the data as the experiment progresses. Note when a smaller load increment is necessary for the same .0005 inch increment. Continue to add another .002 inch elongation.



9. Retract the micrometer, release the load and read the micrometer at no load. Is it still at zero? Explain.
10. Repeat loading, this time beyond previous total elongation. Continue to plot the data as you proceed. Is the curve different this time? Explain. Does the specimen look different?
11. Proceed till fracture occurs. Note the load and elongation. Examine the fracture and explain its appearance.
12. Determine the proportional elastic limit, yield strength, the tensile strength and the Modulus of Elasticity from the data. Compare with published values of 40,000 psi yield, 4500 psi tensile and 10×10^6 psi Modulus of Elasticity.

TAPES

Record something on tape and listen to it.

Remove the tape, and with a magnet, stroke on the part you recorded. Put it back on the machine and listen to it.

What does this tell you about how recording tapes work?

MORE: Design an experiment to tell you more about how recording tapes work and/or how a tape recorder works.

Caution: Do not use a permanent magnet on or near a tape recorder.

SOURCES OF INFORMATION AND MATERIALS

SOURCES OF INFORMATION AND MATERIALS

The organizations listed below include professional societies, governmental agencies, private industries, and private businesses. Many offer free or inexpensive media on careers, schooling, manufacturing, safety, specific industrial materials, and similar topics in the form of films, slides, books and booklets, charts, and guest speakers. Requests on school letterhead for assistance should be short and specific, listing the type of assistance needed. Specifics on the type of media offered by these organizations can be found in such references as Materials for Occupational Education by Patricia Schuman or Educators Guide to Free and Inexpensive Films by Educators Progress Service which are available in libraries of schools, universities, and public libraries. A surprising amount of high quality instructional assistance is available through these sources and requires only a simple letter of request. For some societies addresses change frequently so a check of the current address is adviseable.

GENERAL

American Association for the Advancement of Science, 1515 Massachusetts Avenue, N.W., Washington, DC 20005.

American National Standards Institute, 1430 Broadway, New York, NY 10018.

American Society for Engineering Education, Suite 400, 1 Dupont Circle, Washington, DC 20036.

American Society of Certified Engineering Technicians, 2029 K Street, N.W., Washington, DC 20006.

American Society of Safety Engineers, 850 Busse Highway, Park Ridge, IL 60068.

Association Films, Inc., 600 Madison Avenue, New York, NY 10022.

E. I. DuPont De Nemours & Co., Industrial Training Service, Room 7450, Nemours Building, Wilmington, DE 19898.

Engineers Council on Professional Development, 345 East 47 Street, New York, NY 10017.

Engineers Joint Council, 345 East 47 Street, New York, NY 10017.

General Electric Co., Educational Relations, Ossining, NY 10562.

Modern Talking Picture Service, 16 Spear Street, San Francisco, CA 94105.

NASA, Langley Research Center, Educational Programs Director, Hampton, VA 23665.

National Academy of Engineering, Commission on Education, 2101 Constitution Avenue, Washington, DC 20418.

National Academy of Sciences, National Academy of Engineering, National Research Council, 2101 Constitution Avenue, Washington, DC 20418.

National Audiovisual Center, General Services Administration, National Archives and Records Service, Washington, DC 20409.

National Referral Center for Science and Technology, Library of Congress, 10 First Street, S.E., Washington, DC 20540.

National Safety Council, 425 North Michigan Avenue, Chicago, IL 60611.

National Society of Professional Engineers, 2029 K Street, N.W., Washington, DC 20006.

National Technical Information Service, U. S. Department of Commerce, Operations Division, Springfield, VA 22151.

U. S. Atomic Energy Commission, Audio-visual Branch Division of Public Information, Washington, DC 20545.

U. S. Government Printing Office, Division of Public Relations, Washington, DC 20402.

Visual Aids Service, University of Illinois, Champaign, IL 60004.

Vocational Guidance Manuals, 235 East 45 Street, New York, NY 10017.

Western Electric Co., Motion Picture Bureau, Public Relations Division, 195 Broadway, New York, NY 10007.

MATERIALS

American Society for Nondestructive Testing, Inc., 914 Chicago Avenue, Evanston, IL 60202.

American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.

International Material Management Society, 214-B Huron Towers, 2200 Fuller Road, Ann Arbor, MI 48105.

CERAMICS

American Scientific Glass Blowing Society, 309 Georgetown Avenue, Givinhurst, Washington, DE 19809.

Corning Glass Works, Corporate Communications Division, Corning, NY 14830.

Portland Cement Association, Old Orchard Road, Skokie, IL 60076.

PLASTICS

Society of Plastics Engineers, 656 West Putnam Avenue, Greenwich, CO 06830.

Society of the Plastics Industry, Inc., 250 Park Avenue, New York, NY 10017.

MANUFACTURING

Society of Manufacturing Engineers, 20501 Ford Road, Dearborn, MI 48128.

WOODS

American Forestry Association, 919 17 Street, N.W., Washington, DC 20006.

American Paper Institute, 260 Madison Avenue, New York, NY 10016.

American Wood-Preservers' Association, 1012 14 Street, N.W., Washington, DC 20005.

Forest Products Research Society, 2801 Marshall Court, Madison, WI 53705.

Forest Service, U. S. Department of Agriculture, Washington, DC 20250.

National Forest Products Association, 1619 Massachusetts Avenue, N.W., Washington, DC 20036.

Society of Wood Science and Technology, P.O. Box 5062, Madison, WI 53705.

Western Wood Products Association, Yeon Building, Portland, OR 97204.

METALS

Aluminum Association, 420 Lexington Avenue, New York, NY 10017.

Aluminum Company of America, ALCOA Building, Pittsburgh, PA 15219.

American Foundrymen's Society, Golf and Wolf Roads, Des Plaines, IL 60016.

American Iron and Steel Institute, 633 Third Avenue, New York, NY 10017.

American Society for Metals, 9885 Kinsman Road, Metals Park, OH 44073.

Association of Iron and Steel Engineers, 1010 Empire Building, Pittsburgh, PA 15222.

Copper Development Association, 405 Lexington Avenue, New York, NY 10017.

Forging Industry Association, 55 Public Square, Cleveland, OH 44113.

Metal Powder Industries Federation, 201 East 42 Street, New York, NY 10017.

Metallurgical Society, 345 East 47 Street, New York, NY 10017.

National Association of Corrosion Engineers, 2400 West Loop South, Houston, TX 77027.

Reynolds Metals Co., Richmond, VA 23218.

United States Steel Corp., Educational Services, 525 William Penn Place, Pittsburgh, PA 15230.

PROCESSES

American Society for Quality Control, 161 West Wisconsin Avenue, Milwaukee, WI 53203.

American Society of Mechanical Engineers, 345 East 47 Street, New York, NY 10017.

American Society of Tool and Manufacturing Engineers, 20501 Ford Road, Dearborn, MI 48128.

American Welding Society, United Engineering Center, 345 East 47 Street, New York, NY 10017.

Cincinnati Milling Machine Co., 4701 Marburg Avenue, Cincinnati, OH 45209.

Hobart Brothers Co., Box DM-428, Troy, OH 45373.

James F. Lincoln Arc Welding Foundation, P.O. Box 3035, Cleveland, OH 44117.

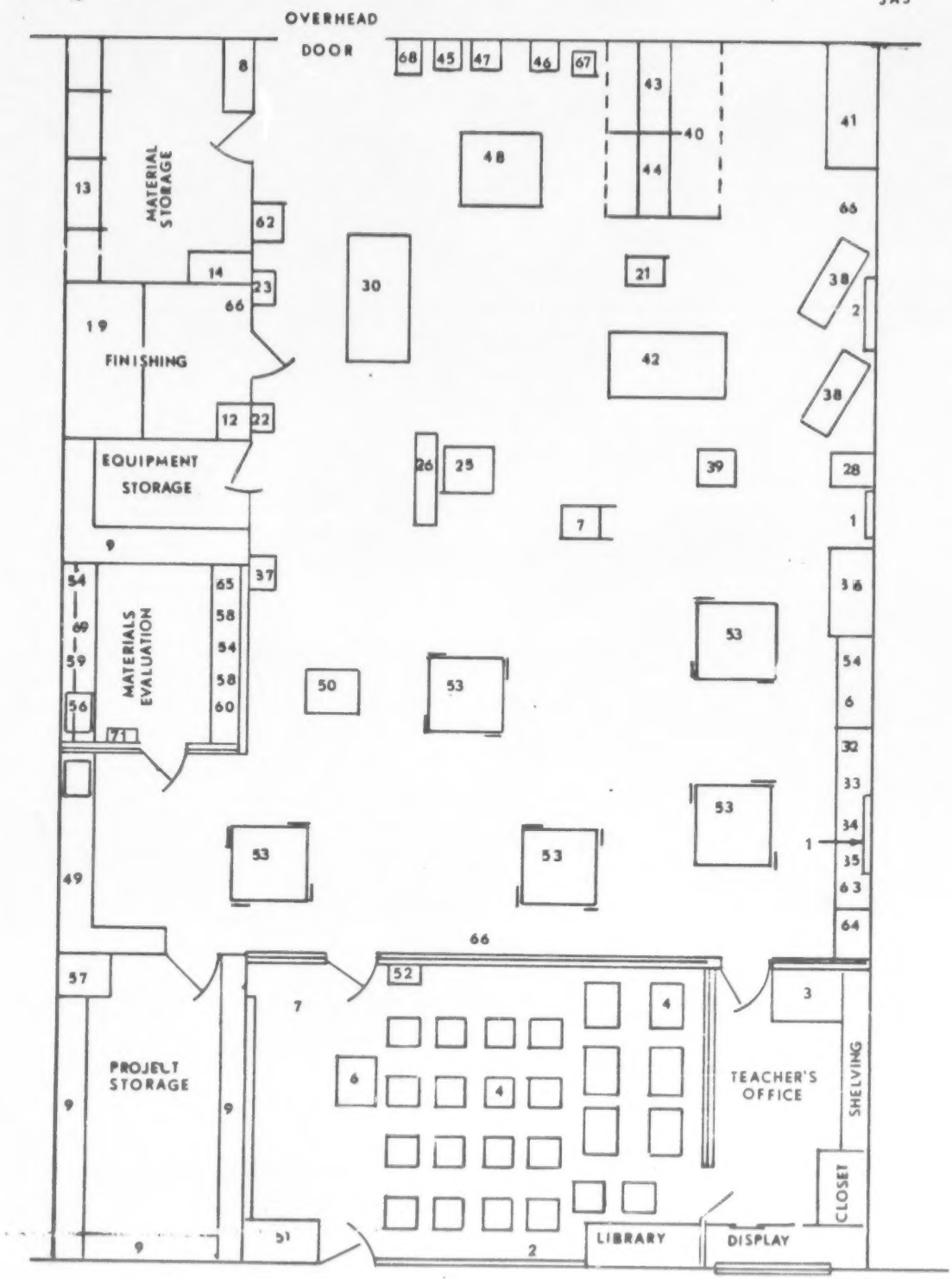
Numerical Control Society, 44 Nassau Street, Princeton, NJ 08540.

FACILITIES AND EQUIPMENT

MATERIALS AND PROCESSES TECHNOLOGY LABORATORY DESIGN CONCEPT

SCALE $\frac{1}{10}$" : 1'-0"

2-77-80
JAJ



MATERIALS AND PROCESSES TECHNOLOGY

INDUSTRIAL ARTS EDUCATION SERVICE
APPROVED EQUIPMENT LIST

ITEM	DESCRIPTION
1	Chalkboard
2	Tackboard
3	Teacher's Desk
4	Student Desk
5	Drafting Station
6	Teaching Station w/Overhead Projector
7	Overhead Screen
8	Shelving 24" Material and Supply Storage
9	Shelving 24" Project Storage
10	Shelving 12" Book and Material Storage
11	Air Compressor
12	Cabinet, Paint and Finishing Supply Storage (Fire Proof)
13	Rack, Lumber Storage
14	Rack, Plywood Storage
15	Wardrobe Closet
16	File Cabinet 4 Drawer
17	Work Table 30" x 48"
18	Spray Booth, Complete w/Spray Apparatus
19	Woodworking Tool Storage Cabinet
20	Band Saw 20" Wood-Metal Cutting
21	Drill Press 15"

ITEM	DESCRIPTION
22	Belt and Disc Sander w/Built-in Dust Collector
23	Wood Lathe 12"
24	Surfacer 16"
25	Jointer 6"
26	Table Saw 10"
27	Scroll Saw 24"
28	Grinder Tool Sharpening (Slow Speed)
29	Glue Bench w/Clamp Storage
30	Wall Bench, Wood Top w/Storage Lockers 24" x 12'
31	Plastics Oven
32	Injection Molder
33	Rotational Molder
34	Thermoformer
35	Metalworking Tool Storage Cabinet
36	Drill Press 15"
37	Metal Lathe 11"
38	Milling Machine Horizontal/Vertical Comb.
39	Furnace, Combination Heat Treating and Melting
40	Bench, Foundry Molding
41	Sheet Metal Work Center w/Squaring Shears, Folder, Brake, Slip Rolls and Notcher Storage Below 24" 20 Gauge Capacity
42	Welder, Arc complete w/Table
43	Welder, Gas complete w/Table and Cylinder Cart
44	Welder, Electric Spot
45	Grinder, Pedestal
46	Buffer, Pedestal

ITEM	DESCRIPTION
47	Work Bench, Steel Top w/4 Metalworkers Vises
48	Ceramics Work Center complete w/Sink and Kiln
49	Universal Testing Machine
50	Drafting Equipment and Other Storage
51	Safety Glass Storage
52	4 Station Work Bench, 4 Woodvises, and Storage Cabinets
53	Woodtop Bench w/Storage Cabinets
54	Glass Front Wall Storage Cabinets
55	Sink
56	Refrigerator
57	Metallograph w/Camera Accessories
58	Metallurgical Grinder and Polisher
59	Portable Hardness Tester
60	Heated Laminating Platen Press
61	Lost Wax (Investment) Centrifugal Casting Outfit
62	Thermoplastic Strip Heater
63	Portable Plastic Storage: Plastic Welder, Heat Gun, Engraver, Fiberglas Equipment, Pressure Cooker, Hot Plate
64	1000G Balance Beam
65	Electric Range
66	Oily Rag Can
67	Abrasive Cut-off Saw
68	Emergency Shower and Eye Wash Station
69	Nondestructive Testing Storage: Dye Penetrate Kit, Magnetic Particle Kit, Ultraviolet Kit